



National
Aeronautics and
Space
Administration

Educational Services

Teachers & Faculty

Grades K-University

EP-2004-02



Earth Science Enterprise

2004

Education Catalog





Earth Science Enterprise

2004

Education Catalog



Table of Contents

| | |
|---------------------------|---|
| <i>Introduction</i> | 1 |
|---------------------------|---|

Elementary and Secondary

| | |
|--|---|
| Aeronautics and Earth Science Academy..... | 1 |
| Alaska Alliance for Earth System Science Education | 1 |
| Ames Aerospace Encounter..... | 2 |
| Celebration of Women in Mathematics | 2 |
| Center for Coastal Zone Assessment and Remote Sensing | 2 |
| Challenger Center for Space Science Education | 3 |
| Challenger's e-Mission: Operation Montserrat | 3 |
| The Chesapeake Bay Watershed Initiative | 3 |
| DEVELOP | 4 |
| The Dynamic Earth..... | 4 |
| Earth Observatory..... | 5 |
| Earth Observing System (EOS) Education Project | 5 |
| Earth Science Component for Academic Professional Enhancement (ESCAPE) | 5 |
| Earth Science Professional Development Workshops at NASA/JPL Educator Resource Center..... | 5 |
| Earth System Science Academy | 6 |
| Earth System Science Education Alliance (ESSEA)..... | 6 |
| Earthworks: Earth System Science for Secondary Teachers | 6 |
| Extending NASA Earth Science Data Use to the K–12 and Citizen Scientist Communities | 6 |
| Federation of Earth Science Information Partners..... | 7 |
| Forest Watch..... | 7 |
| The GAIA Crossroads Project | 7 |
| The GLOBE Program | 8 |
| ISS EarthKAM | 8 |
| The JASON Project | 8 |

| | |
|---|----|
| Johns Hopkins Earth/Space Science Graduate Studies Program | 9 |
| Learning Technologies Project (LTP) | 9 |
| Mathematics of the Great Dismal Swamp Project | 9 |
| Measuring Vegetation Health | 9 |
| Minority University-Space Interdisciplinary Network (MU-SPIN) | 10 |
| NASA Earth Science Missions— Education Programs and Resources | 10 |
| NASA Explorer Schools | 13 |
| NASA GISS Institute on Climate and Planets (ICP) | 13 |
| NASA Satellites Study Earth's Atmosphere: CALIPSO, CloudSat and Aura Working with the GLOBE Project | 14 |
| NASA Student Involvement Program (NSIP) | 14 |
| National Space Grant College and Fellowship Program (NSGCFP) | 14 |
| Near Earth Achievable Remote Sensing (NEARS)..... | 15 |
| Odyssey of the Mind..... | 15 |
| PIPELINES..... | 15 |
| Practical Uses of Math And Science (PUMAS)..... | 16 |
| Project 3D-VIEW | 16 |
| Project ESCAPE..... | 16 |
| Sensing Cape Cod..... | 17 |
| Students' Cloud Observations On-Line (S'COOL)..... | 17 |
| Summer High School Apprenticeship Research Program (SHARP)..... | 17 |
| Tropical Center for Earth and Space Studies (TCESS) | 18 |
| Virginia Geospatial Extension Program | 18 |
| Visiting Student Enrichment Program (VSEP) | 18 |
| You Be the Scientist with Satellite Imagery in the EZ/EC Communities (YBTS) | 19 |

Higher Education

| | |
|--|----|
| Center for Coastal Zone Assessment and Remote Sensing | 1 |
| Center for Hydrology, Soil Climatology and Remote Sensing's (HSCaRS) Undergraduate Summer Enrichment Program | 1 |
| Chautauqua Short Courses for College Teachers: 2004 Faculty Development Program | 2 |
| Curriculum Improvement Partnership Award (CIPA) Program | 2 |
| DEVELOP | 2 |
| Earth Observatory | 3 |
| Earth Science Component for Academic Professional Enhancement (ESCAPE) | 3 |
| Earth System Science Education Alliance (ESSEA) | 3 |
| Earth System Science Fellowship Program | 4 |
| ESSE 21: Earth System Science Education for the 21st Century | 4 |
| Federation of Earth Science Information Partners | 4 |
| Geospatial Workforce Development Center (GeoWDC) | 5 |
| Goddard Coastal Research Graduate Fellowship Program (GCR) | 5 |
| Graduate Student Researchers Program (GSRP) | 5 |
| Graduate Student Summer Program in Earth System Science (GSSP) | 6 |
| GSFC/Howard University Fellowship in Atmospheric Science (GoHFAS) | 6 |
| Howard University Program in Atmospheric Sciences (HUPAS) | 7 |
| Minorities Striving and Pursuing Higher Degrees of Success (MS PHD'S) in Earth System Science | 7 |
| Minority University-Space Interdisciplinary Network (MU-SPIN) | 7 |
| NASA Academy | 8 |
| NASA EOS Higher Education Alliance | 8 |
| NASA Faculty Fellowship Program | 9 |
| NASA GISS Institute on Climate and Planets (ICP) | 9 |
| NASA Opportunities for Visionary Academics (NOVA) | 9 |
| NASA Summer School for High Performance Computational Earth and Space Sciences (HPC) | 10 |
| National Space Grant College and Fellowship Program (NSGCFP) | 10 |
| New Investigator Program (NIP) in Earth Science | 11 |
| Partnership Awards for the Integration of Research into Undergraduate Education (PAIR) | 11 |

| | |
|--|----|
| Satellite Observations in Science Education | 12 |
| Significant Opportunities in Atmospheric Research and Science (SOARS) | 12 |
| Summer Institute on Atmospheric, Hydrospheric and Terrestrial Sciences | 12 |
| Virginia Geospatial Extension Program | 12 |
| Visiting Student Enrichment Program (VSEP) | 13 |

Informal Education

| | |
|---|---|
| The Dynamic Earth | 1 |
| Earth as Art | 1 |
| Earth Observatory | 2 |
| Earth Science Enterprise Museum Support | 2 |
| E-Theater | 2 |
| Eyes on Earth | 2 |
| Federation of Earth Science Information Partners | 3 |
| Forces of Change | 3 |
| Global Climate Change and You: Workshops for Girl Scout Leaders | 3 |
| Global Links | 4 |
| Immersive Earth: Teaching Earth Science by Fulldome Experiences and Hands-On Exhibits | 4 |
| Museums Teaching Planet Earth | 4 |
| Virginia Geospatial Extension Program | 4 |
| Where on Earth...? MISR Mystery Image Quizzes | 5 |

Products & Resources

| | |
|----------------------------------|----|
| Elementary & Secondary | 1 |
| Higher Education | 22 |
| Informal Education | 29 |

NASA Resources for Educators

| | |
|---|---|
| Central Operation of Resources for Educators (CORE) | 1 |
| Educator Resource Center Network (ERCN) | 1 |
| Education Home Page | 2 |
| NASA Portal | 2 |
| NASA Television | 2 |
| Spacelink | 2 |

| | |
|--|---|
| Acknowledgements/Photo Credits | 1 |
|--|---|



Earth Science Enterprise

2004

Education Catalog



The NASA Vision

*To improve life here,
To extend life to there,
To find life beyond.*

The NASA Mission

*To understand and protect our home planet,
To explore the universe and search for life,
To inspire the next generation of explorers
...as only NASA can.*

NASA's Earth Science Enterprise (ESE) uses the compelling context of Earth system science to engage students in the process of scientific inquiry, helping them to achieve in science, technology, engineering and mathematics (STEM) while developing a deeper understanding of the complexities of the Earth system. The interdisciplinary field of Earth system science explores interactions among the major Earth components—continents, oceans, atmosphere, ice and life—in pursuit of answers to the fundamental question, “How is the Earth system changing and what are the consequences for life on Earth?” The knowledge acquired from understanding, characterizing and predicting Earth system change is extended to assist decision makers in such critical areas as public health, aviation safety, air quality and coastal management. Beyond our own world, what we learn about the Earth system is helping NASA explore the universe and search for life. The scientific knowledge we gain about our living planet and the technologies developed to explore Earth shape our approach to exploring other worlds.

The ESE Education Program captures and communicates the excitement of ESE activities in Earth system

science to inspire and motivate students to pursue STEM careers and to effectively translate and deliver ESE research results to the public. Through the development of the workforce pipeline and increased scientific literacy of the public, the ESE Education Program contributes to NASA's education mission by **inspiring the next generation of Earth explorers**. NASA Earth Explorers (earth.nasa.gov/education/explorers) are all ages, with a variety of backgrounds and interests, sharing a curiosity about how the Earth works and the impact Earth system processes have on sustaining life on Earth for current and future generations.

The ESE Education Program offers a diverse array of programs and resources for formal classroom instruction, informal education, and professional and workforce development. The complete listing of ESE education programs, products and resources, along with agency-wide resources for educators, is provided in this online catalog. The **Elementary & Secondary**, **Higher Education**, and **Informal Education** sections feature regional and national programs. **Products & Resources** identifies ESE products and resources for these three educational communities. Products and resources included in this catalog have passed the ESE Education Product Review (earth.nasa.gov/education/esereview), an independent peer review that ensures ESE education products are of high quality and meet science education standards. Agency-wide resources for educators are identified in the **NASA Resources for Educators** section.

To receive the **ESE Education Newsletter**, a monthly email of the latest NASA ESE education news, programs and resources, visit earth.nasa.gov/education/edreports or send an email to: ese_ed_newsletter@listserv.gsfc.nasa.gov.



Elementary & Secondary

NASA's ESE elementary and secondary education programs draw on the compelling context of Earth system science to support teacher professional development and promote student achievement in STEM.

Educators challenge their students and motivate them to achieve by enriching their own backgrounds in Earth system science and STEM. Professional development opportunities include online courses, workshops and other activities that support the classroom study of Earth system science.

The ESE Education program strives to inspire the next generation of Earth explorers through hands-on science education experiences that expose K–12 students to Earth system science subjects and processes. The ESE promotes student achievement in STEM by providing unique learning experiences, including opportunities for students to engage in the practices and perspectives of Earth system science, develop new skills, gain experience working with scientists, and develop a deeper understanding of the diversity of Earth system science-related careers.

The ESE Education Program also sponsors the development of education materials in support of STEM curricula. Curricular support efforts focus on an interdisciplinary approach aligned with national education standards in science, geography, mathematics and technology. A listing of specific ESE education products and how to obtain them is included in the "Products and Resources" section of this catalog.

Aeronautics and Earth Science Academy

The mission of the Medgar Evers College (MEC) Aeronautics and Earth Science Academy (AESA) is to provide underrepresented middle and high school students an enriched academic experience that involves various areas of NASA's strategic enterprises, thus encouraging the pursuit of careers in science, technology, engineering and mathematics (STEM).

Through its classes and workshops, AESA aims to: strengthen students' mathematics, science, computer and communication skills; integrate research and related activities into students' academic experiences in order to encourage enrollment in STEM college preparatory courses; give students the confidence and desire to pursue STEM careers; encourage parental involvement and support of students in learning STEM; and increase the number of underrepresented students in the STEM pipeline. Topics covered include air and water pollution, global warming, weather analysis, science on the Internet, careers in science and technology and writing skills development.

The AESA program is held on weekdays after school, Saturdays and during summer vacations. Parents are encouraged to join the "Parent Café" and participate in science and technology conferences held at MEC.

CONTACTS: Leon Johnson, Department of Physical, Environmental and Computer Science, Medgar Evers College of the City University of New York, **Email:** lpjohnson@mec.cuny.edu; William Harris, AEL Project Director, **Email:** wharris@mec.cuny.org.

Alaska Alliance for Earth System Science Education

The Alaska Alliance seeks to increase public understanding of global climate variability and its relevance to Alaskan communities, and to strengthen teaching and learning of related subjects in K–12 and undergraduate classrooms. To accomplish these objectives, the Alliance:

- Adapts existing science and technology content and education materials (e.g., NASA Earth science education resources);

- Improves systemic efforts by linking existing programs with Earth and environmental education institutions; and
- Helps these programs to increase their scope and reach, particularly within rural Alaska.

The Alaska Alliance includes Alaska GLOBE partners and schools, the Alaska Space Grant Program, Kachemak Bay National Estuarine Research Reserve and the Challenger Learning Center of Alaska, and is collaborating closely with the “Observing Locally, Connecting Globally” project.

CONTACT: Elena Sparrow, Research Associate Professor and Alaska GLOBE Coordinator, 317 O'Neill Bldg., University of Alaska Fairbanks, SNRAS, PO Box 757200, Fairbanks, AK 99775-7200, **Phone:** 907-474-7699, **Email:** elena.sparrow@uaf.edu.

Ames Aerospace Encounter

<http://encounter.arc.nasa.gov>

Created for students in grades 4–6, NASA's Ames Aerospace Encounter is a unique, interactive program designed to stir young people's imaginations and fuel their enthusiasm for science, mathematics and technology. Located in a renovated supersonic wind tunnel, students split their time between four different areas: Space Sciences, Aeronautics, Space Station and Mission Control/Earth Science.

In Space Sciences, students experience some of the basics of physics in fun, physical ways. In Aeronautics, students learn about the principles of flight and wind tunnels and use computers to design airplanes. In Space Station, young people become astronauts on a simulated space station with different experiments to complete. And in Mission Control/Earth Science, children work with a variety of data collected by aircraft and spacecraft to support the space station mission and learn about Earth science.

The Ames Aerospace Encounter is free; groups are accepted on a space-available basis.

CONTACT: Ames Aerospace Encounter, Mail Stop 226-1, NASA Ames Research Center, Moffett Field, CA 94035-1000, **Phone:** 650-604-1110, **Email:** encounter@mail.arc.nasa.gov.

Celebration of Women in Mathematics

<http://nia.ecsu.edu/nrts/2002events/102902cwm/cwm.html>

The Celebration of Women in Mathematics is a one-day event conducted annually on the campus of Elizabeth City State University in North Carolina. The event brings together more than 400 middle and high school girls and their

teachers for a day of mathematics workshops, competitions and career seminars. The objective is to encourage girls to incorporate more mathematics into their studies and to raise the level of mathematics competency in the region of northeastern North Carolina and southeastern Virginia. The celebration is sponsored jointly by the Association for Women in Mathematics and NASA's Minority University–Space Interdisciplinary Network.

CONTACT: Linda Hayden, NASA Network Resources and Training Site, Elizabeth City State University, Box 672, 1704 Weeksville Rd., Elizabeth City, NC 27909, **Phone:** 252-335-3696, **Fax:** 252-335-3790, **Email:** lhayden@umfort.cs.ecsu.edu.

Center for Coastal Zone Assessment and Remote Sensing

Southern University's Center for Coastal Zone Assessment and Remote Sensing (CCZARS) is a NASA University Research Center—a multidisciplinary research unit established at a minority institution to focus on a specific area of NASA interest. The center is supporting the mission of NASA's Stennis Space Center by conducting research in the areas of fisheries habitat assessment, coastal change, land use/land cover change and urban sprawl. CCZARS is also developing related education and outreach initiatives:

- Interdisciplinary faculty research teams will develop course modules and provide technical material.
- A “Distinguished Visiting Researcher” position will be created; incumbent will teach and provide research assistance.
- An undergraduate research program, CCZARS Scholars, will be established, and on-site research experiences for undergraduate and graduate researchers will be provided.
- K–12 students will be introduced to fundamental Earth science concepts and encouraged to pursue careers in science, math, engineering and technology.
- Three-day workshops for current industry partners and K–12 teachers will provide training in geographic information systems (GIS) and remote sensing.
- An annual conference on coastal zone assessment and remote sensing will be held.

CONTACTS: Michael Stubblefield, Director, Southern University and A&M College, PO Box 9764, Baton Rouge, LA 70813, **Phone:** 225-771-4724, **Fax:** 225-771-4722, **Email:** mastub@bellsouth.net; Deidre Hardy-Street, Program Manager, Southern University and A&M College, PO Box 9764, Baton Rouge, LA 70813, **Phone:** 225-771-4724, **Fax:** 225-771-4722 **Email:** dhardy1@bellsouth.net.

Challenger Center for Space Science Education

<http://www.challenger.org>

The Challenger Center for Space Science Education is an international nonprofit education organization created in 1986 by the families of the astronauts lost during the Challenger space shuttle mission. Using space exploration as a theme, the center's highly acclaimed programs inspire students to pursue math, science and technology studies, while at the same time helping them develop critical life skills.

The organization launched the Challenger Learning Center Network in 1987. Challenger Learning Centers use technology-rich educational environments to create hands-on learning experiences. They offer a variety of programs, from mission simulations for students to professional development workshops for instructors. Each year, more than 400,000 students visit Challenger Learning Centers across the United States, Canada and the United Kingdom.

The four mission scenarios offered at Challenger Learning Centers—Encounter Earth, Voyage to Mars, Return to the Moon, and Rendezvous with a Comet—allow students to rev up their imaginations and transform themselves into astronauts, scientists and engineers. All of the scenarios meet or exceed national science education standards, and were developed with NASA engineers and scientists to ensure an authentic experience. Mission scenarios and fees vary by location. Log on to the Web site to find the Challenger Learning Center nearest you.

CONTACT: Challenger Center for Space Science Education, 1250 North Pitt St., Alexandria, VA 22314, **Phone:** 703-683-9740, **Fax:** 703-683-7546.

Challenger's e-Mission: Operation Montserrat

<http://clc.wju.edu/om>

On September 4, 1996, the island of Montserrat was the world's most dangerous place. Two potentially catastrophic events converged simultaneously upon this Caribbean paradise—an awakening volcano and a Category 3 hurricane.

Using the Internet, students in grades 5–10 connect to the Challenger Learning Center's Mission Control at Wheeling Jesuit University for a unique, interactive learning adventure. After completing an online application and resume, students form emergency response teams and prepare for their mission by collecting and analyzing relevant Earth science data.

On mission day, students join one of four crisis management teams—the Volcano Team, Hurricane Team, Evacuation Team or Communication Team—and use

science knowledge and math skills to avert possible disaster. In a two-hour period, the Volcano and Hurricane teams rally to analyze real-time data and determine the risks to the people on the island. The analyses are then presented to the Evacuation Team to determine the rescue plan.

Throughout the mission, the Communication Team is in live contact with Mission Control via video, audio and a "chat window."

For teachers, the mission and the pre-mission curriculum are a new way to introduce various science and math topics. Resources for teachers include training workshops, lesson plans, assessment materials and online support. The mission package also includes technology support to help teachers prepare their classrooms for mission day.

CONTACT: Jackie Shia, e-Mission Development Center, Challenger Learning Center at Wheeling Jesuit University, 316 Washington Ave., Wheeling, WV 26003, **Phone:** 304-243-4431, **Email:** jshia@cet.edu.

Operation Montserrat is also offered by the following Challenger Learning Centers:

- Challenger Learning Center of Alaska:
<http://akchallenger.org>
- Challenger Learning Center of Arizona:
<http://www.azchallenger.org>
- Honeywell Challenger Learning Center at California State University, Dominguez Hills:
<http://www.csudh.edu/clc>
- Challenger Learning Center at Chabot Space & Science Center: <http://www.chabotspace.org>
- Challenger Learning Center of Colorado Springs:
<http://www.clccs.org>
- Challenger Learning Center of Northwest Indiana:
<http://www.clcnwi.com>
- Challenger Learning Center at Paducah:
<http://www.clcpaducab.org>
- Challenger Learning Centre, National Space Centre, Leicester, United Kingdom:
<http://www.spacecentre.co.uk>

The Chesapeake Bay Watershed Initiative

<http://www.cbwi.org>

The Chesapeake Bay Watershed Initiative (CBWI) is a hydrology-based scientific experiment being conducted by K–12 students in the mid-Atlantic region. Students are working to determine if possible causes and effects of changes in nutrient levels in tributaries of the bay can be correlated with changes in land cover, land use or weather phenomena, as observed from the ground and from space. The experiment is a team project requiring students with

varying levels of expertise to conduct in situ measurements of water quality, compile weather information and analyze Landsat satellite imagery to investigate spatial and temporal changes in land use and land cover. While students are held accountable for the accuracy of their work, they are not graded on their participation.

The CBWI has immediate relevance to the Chesapeake Bay, but the experiment could be adopted and adapted for use by students and educators in other parts of the nation as well.

The project was organized and implemented in early 1998 by state Space Grant consortia in Delaware, Maryland, Pennsylvania, Virginia, West Virginia and the District of Columbia. These consortia are all members of NASA's National Space Grant College and Fellowship Program. The Maryland Space Grant Consortium was selected to organize and manage the CBWI on behalf of the other state consortia.

CONTACT: Robert Popham, **Email:** rwpopham@prodigy.net.

DEVELOP

<http://develop.larc.nasa.gov>

DEVELOP is an initiative that extends NASA Earth science research to local communities. Student teams demonstrate to community leaders prototype applications of NASA Earth science measurements and predictions addressing local policy issues. The program is a year-round activity, with teams located nationwide. High school through graduate students with strong interests in science, technology and policy are encouraged to apply.

DEVELOP students initiate and research projects in response to challenges that communities pose at leadership forums, such as governors' conferences and association meetings. Their final research results are presented as computer-generated visualizations. The activity is student-led, with NASA scientists serving as advisors. The student projects use NASA Earth science mission data and models, and cover all 12 NASA applications of national priority: agricultural efficiency, air quality, aviation safety, carbon management, coastal management, disaster management, ecological forecasting, energy management, homeland security, invasive species, public health and water management.

Each project requires partnerships with the target community to achieve the greatest return on investment. Students work with industry, nonprofit organizations or local governments to attract long-term technology and education benefits to the community.

In addition to the core Earth science applications projects, students also conduct outreach activities. For the purposes of advanced visualization demonstrations, students

constructed a portable visual immersion environment. DEVELOP also supports the federal Computers for Learning Program by establishing Earth science education computer labs in schools nationwide.

CONTACTS: DEVELOP National Program Office, MS 307, NASA Langley Research Center, Hampton, VA 23681-2199, **Phone:** 757-864-3761; **Fax:** 757-864-7890, **Email:** michael.l.ruiz@nasa.gov; DEVELOP Western Regional Office, MS 239-20, NASA Ames Research Center, Moffett Field, CA 94035-1000, **Phone:** 650-604-3614; **Fax:** 650-604-1088, **Email:** joseph.w.skiles@nasa.gov.

The Dynamic Earth

<http://www.discoverycube.org>

Located in Santa Ana, California, Discovery Science Center is a nonprofit organization dedicated to educating young minds, assisting teachers and increasing public understanding of science, math and technology through interactive exhibits and programs. The center's Dynamic Earth program includes:

- A curriculum packet containing lesson plans on several topics, such as earthquakes, atmospheric sciences and water quality monitoring;
- A program for training teachers in the use of the lesson plans—the six-hour training covers 2–3 weeks of classroom instruction; and
- An interactive science presentation featuring hands-on exhibits, including an earthquake simulation room, an eight-foot freestanding tornado, and a kalliroscope that models the fluid dynamics of the ocean and atmosphere.

Participants in Dynamic Earth investigate various topics, including plate tectonics and the changing patterns of land, sea and mountains on the Earth's surface; how the Sun's heating of the Earth's surface drives atmospheric and oceanic circulations, global weather patterns and geographical distribution of marine and terrestrial organisms; and how human impacts on the Earth's atmosphere and waterways affect all life on Earth.

CONTACT: Janet Yamaguchi, Vice President, Education, Discovery Science Center, 2500 North Main St., Santa Ana, CA 92705, **Phone:** 714-542-2823, **Fax:** 714-542-2828, **Email:** jyamaguchi@discoverycube.org.

Earth Observatory

<http://earthobservatory.nasa.gov>

NASA's Earth Observatory is an interactive Web-based magazine where the science-attentive public can obtain new satellite imagery and scientific information about our home planet. The focus is on Earth's climate and environmental change. The site is also designed to be useful to public media and educators. Any and all materials published on the Earth Observatory are freely available for re-publication, re-use or re-broadcast (except in rare cases where copyright is indicated).

Visit the Earth Observatory to read feature articles on wide-ranging Earth system science topics, download datasets and images for analysis, read breaking news, learn about current and planned Earth missions, search an online library for reference materials, track natural hazards around the world in near real time, and access interactive experiments and classroom activities.

CONTACT: David Herring, Code 913, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6219, **Email:** dherring@climate.gsfc.nasa.gov.

Earth Observing System (EOS) Education Project

<http://www.eoscenter.com>

The University of Montana's EOS Education Project disseminates Earth imagery, develops interdisciplinary programs and provides opportunities for teachers and students to learn about the interpretation, use and relevance of geospatial and technology-related information. Its primary focus is to serve the needs of the international preK–16 educational community.

In order to achieve its objectives, the EOS Education Project:

- Uses emerging technologies such as map, image and document services to deliver geospatial and multimedia information directly into the classroom;
- Provides teacher development programs in the form of on-site and Internet-based classes in relevant technologies, such as geographic information systems (GIS), at little or no cost to the educational community;
- Develops outreach programs combining teacher in-service and pre-service workshops in various curricula and emerging technologies;
- Provides thematic education programs and materials, such as the EOS Newsletter, to increase public awareness about NASA's Earth science educational resources; and
- Makes resources available to create, develop and share materials through a computer-based communications

system capable of providing easy access to information and curricula (it is hoped that this technology can be used to assist schools funded by the Bureau of Indian Affairs).

CONTACT: Jeff Crews, Assistant Director, NASA EOS Education Project, James E. Todd Building, University of Montana, Missoula, MT 59812, **Phone:** 406-243-2644, **Fax:** 406-243-2047, **Email:** jcrews@eoscenter.com.

Earth Science Component for Academic Professional Enhancement (ESCAPE)

<http://tellus.ssec.wisc.edu/outreach/ESCAPE/esc.htm>

This course addresses the professional development needs of upper elementary, middle and high school science teachers in Wisconsin and neighboring states by offering an online Earth system science course in conjunction with the GETWISE project. ESCAPE investigates deforestation, volcanoes, hurricanes and ice shelf disintegration. GETWISE currently features two lecture series, one in Earth system science and another focusing on the solar system.

Two graduate credits are available through the University of Wisconsin-Madison's Department of Atmospheric and Oceanic Sciences upon successful completion of the ESCAPE course.

CONTACT: Margaret Mooney, Office of Space Science Education-Space Science & Engineering Center, University of Wisconsin-Madison, 1225 W. Dayton St., Madison, WI 53706, **Email:** mooney@ssec.wisc.edu.

Earth Science Professional Development Workshops at NASA/JPL Educator Resource Center

<http://education.jpl.nasa.gov/resources/workshops.html>

Starting in spring 2004, NASA's Jet Propulsion Laboratory (JPL) will be hosting Earth science workshops on a regular basis through the NASA/JPL Educator Resource Center in Pomona, California. NASA education specialists will conduct the workshops, which are geared toward in-service and pre-service K–12 educators and will cover a variety of topics, including NASA's unique missions and results. The workshops will provide and utilize NASA curriculum support products, are based on national standards and can be aligned with state standards. Credit is available.

CONTACT: Paula Padilla, Educator Resource Center Coordinator, Jet Propulsion Laboratory, 4800 Oak Grove Dr., MS 180-109, Pasadena, CA 91108, **Phone:** 909-397-4420, **Email:** paula.padilla@jpl.nasa.gov.

Earth System Science Academy

<http://nia.ecsu.edu/nrts/nrtsmisc/essa.html>

The Earth System Science Academy is one of the major K–12 Earth system science initiatives sponsored by Elizabeth City State University's Network Resources and Training Site, which is funded by NASA's Minority University-Space Interdisciplinary Network. During the two-day summer academy, teachers tour the Great Dismal Swamp and become actively involved with water testing techniques. Teachers attend both geoscience and Internet workshops. Internet workshops focus on NASA Earth system science educational resources. The Academy offers educators the opportunity to learn about the health of local waterways and the Great Dismal Swamp, and challenges educators to develop new skills through the experience of working with university and NASA researchers.

Included in the Academy is a tour of the Great Dismal Swamp Boardwalk, hands-on water quality labs and workshops on Earth system science.

CONTACT: Linda Hayden, NASA Network Resources and Training Site, Elizabeth City State University, Box 672, 1704 Weeksville Rd., Elizabeth City, NC 27909, **Phone:** 252-335-3696, **Fax:** 252-335-3790, **Email:** lhayden@umfort.cs.ecsu.edu.

Earth System Science Education Alliance (ESSEA)

<http://www.cet.edu/essea>

Sponsored by NASA's ESE, ESSEA is an exciting and innovative professional development program for K–12 teachers. Participating universities, colleges and science education organizations are offering Earth system science online graduate courses to in-service and pre-service educators. The courses use an innovative instructional design model, are delivered over the Internet and feature student-centered, knowledge-building virtual communities. A master teacher and/or Earth system scientist moderate participants, acting as guides and mentors throughout the 16-week courses.

The three courses can be viewed at the following sites:

- Elementary School Teachers' Earth System Science Course: <http://www2.cet.edu/ete/bilk4/main.html>
- Middle School Teachers' Earth System Science Course: <http://www2.cet.edu/ete/5-8/main.html>
- High School Teachers' Earth System Science Course: <http://www2.cet.edu/ete/bil912/main.html>

The courses were developed within the Center for Educational Technologies (CET) at Wheeling Jesuit University. ESSEA is a partnership between CET and the

Institute for Global Environmental Strategies, with the participation of 18 colleges and universities.

CONTACT: A listing of ESSEA participating universities and contact information, courses and schedules is available at <http://www.cet.edu/essea> (click on the link for "Course Offerings"). Course costs will vary by university. For general program information, contact: Claudia Dauksys, **Phone:** 703-312-0827, **Email:** essea@strategies.org.

Earthworks: Earth System Science for Secondary Teachers

<http://cires.colorado.edu/~k12/earthworks>

Run by the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado at Boulder, Earthworks is a free one-week workshop in the Rocky Mountains designed to help secondary teachers create Earth system science research projects for their students. The workshop is geared toward new in-service teachers and is also suitable for experienced teachers who want to learn more about Earth system science. No previous knowledge of Earth science is required.

The 2004 Earthworks will be held June 19–25 at the Cal-Wood Conservation Education Resource Center, approximately 15 miles northwest of Boulder, Colorado. Travel, lodging, meals and curriculum materials are provided at no charge. Participants can choose from dormitory-style cabin accommodations or outdoor campsites. University credit is available at cost.

Teachers will work in small groups with scientists in designing and conducting research projects and investigating Earth system science at the local level—through the interconnections between the geosphere, atmosphere, biosphere and hydrosphere. Through fieldwork, observations and small-group discussions, a variety of teaching and learning techniques will be practiced.

CONTACT: Genny Healy, CIRES, EARTHWORKS, UCB 216, University of Colorado, Boulder, CO 80309, **Phone:** 303-735-3641, **Email:** ghealy@cires.colorado.edu.

Extending NASA Earth Science Data Use to the K–12 and Citizen Scientist Communities

<http://mynasadata.larc.nasa.gov>

This project will make NASA Earth science data sets accessible to the K–12 community by extracting parameters of interest and making data available in a format that can be easily downloaded and explored. The focus will first be on atmospheric science data currently held at the NASA

Langley Atmospheric Sciences Data Center. Suggestions from teachers to help guide the selection and development of useful data sets are welcome.

The project will also involve open-source development of tools for data manipulation and access, and the development of a network of citizen scientists who are willing to assist teachers in their community with the use of these data. Teacher workshops are also planned to help teachers get started with use of these data and to provide feedback on ease of use and areas of improvement.

CONTACT: Lin Chambers, Atmospheric Sciences, NASA Langley Research Center, MS 420, Hampton, VA 23681-2199, **Phone:** 757-864-4371, **Fax:** 757-864-7996, **Email:** Lin.H.Chambers@larc.nasa.gov.

Federation of Earth Science Information Partners

<http://www.esipfed.org>

The Federation of Earth Science Information Partners (ESIP) brings together government agencies, universities, nonprofit organizations and businesses in an effort to make Earth science information available to a broader community. NASA is a sponsoring agency of the ESIP Federation.

The objective of the Federation is to evolve methods that make Earth science data (satellite and ground-based) easy to preserve, locate, access and use for all beneficial applications, including research, education, commercial development, agriculture, land management, environmental monitoring, policy making and many other applications.

Visit the Federation Web site to learn about ESIP education services and products for elementary through college levels, informal education and professional development.

CONTACT: Dave Jones, President of the ESIP Federation, Columbia Corporate Park 100, 6021 University Blvd., Suite 140, Ellicott City, MD 21043, **Phone:** 410-203-1316, **Fax:** 410-203-9341, **Email:** dave@stormcenter.com.

Forest Watch

<http://www.forestwatch.sr.unh.edu>

Forest Watch is an environmental education program developed and run by the Complex Systems Research Center at the University of New Hampshire (UNH). The program is designed to introduce both teachers and their students to field, laboratory and satellite data analysis methods for assessing the health of local forest stands. Forest Watch conducts workshops that help K–12 teachers introduce their students to hands-on techniques for evaluating the

health of white pine (*Pinus strobus*), a bio-indicator for tropospheric ozone damage. Through Forest Watch, students become actively involved in meaningful scientific research, as students and teachers set up permanent sampling plots in a forest stand and conduct several ecological and biophysical measurements using scientific protocols. The data students collect is a valuable resource for UNH researchers.

Forest Watch has two main objectives: 1) to introduce teachers to techniques that allow students to assess environmental conditions of forest stands and tree species over time; and 2) to provide data to research scientists in order to assess the regional impacts of air pollution on forested species. In conducting ecological site assessments, students are introduced to several science disciplines, including botany, biology, chemistry and physics, as well as some non-scientific disciplines. Professional development workshops are offered to teachers around the New England region.

CONTACTS: Barry Rock, Program Director, or Mike Gagnon, Program Coordinator, Complex Systems Research Center, Morse Hall, University of New Hampshire, Durham, NH 03824, **Phone:** 603-862-1792, **Fax:** 603-862-0188, **Email:** forestwatch@unh.edu.

The GAIA Crossroads Project

<http://www.bigelow.org/~gaia>

The Gaia Crossroads Project is a K–12 education project that explores the value of remotely sensed data as a resource for learning. Since its inception in June 1990, this program has been implemented at all grade levels in more than 94 schools throughout Maine and New Hampshire. Using the imagery provided, students are able to study and interpret satellite images of their local communities. After an initial focus on the local environment, the program expands to include images with broader geographic coverage—including images of the Gulf of Maine and the North Atlantic for studying oceanography, weather satellite images for studying meteorology and images of tropical rain forests for studying global ecosystems. The project provides ongoing teacher training and technical support.

The Gaia Crossroads Project: Guidebook to Using Satellite Imagery in the Classroom and Community contains background information on the project, a remote-sensing primer, hands-on tutorials, ideas for setting up the program in a classroom, more than 60 activities written and tested by teachers and an extensive listing of resources.

CONTACT: Cyndy Erickson, Project Director, **Email:** gaiaxroads@bigelow.org or: gaiaxroads@earthlink.net.

The GLOBE Program

<http://www.globe.gov>

GLOBE is a worldwide network of K–12 students who, under the guidance of trained teachers, make a core set of environmental observations and report their data via the Internet. NASA scientists use GLOBE data in their research and provide feedback to the students. Maps and graphs based on GLOBE student data can be created on the program's Web site, providing "real-life" information for student inquiry. The idea that Earth is a system of interconnected parts is at the root of the program. Observations and measurements cover the following areas: Atmosphere/Climate, Hydrology, Land Cover/Biology, Soils and Phenology.

There is no cost to participate in the program in the United States. GLOBE supplies educational materials and an interactive Web site; and educational institutions, including colleges and universities, partner with GLOBE to train teachers in protocols for collecting data. To participate, a school must have one or more teachers attend a training workshop, make equipment available to students for taking measurements and provide Internet access for the reporting of data. Nobel Laureate Dr. Leon Lederman says, "GLOBE is the quintessentially ideal program for involving kids in science."

Teachers and students from more than 14,000 schools in over 100 countries currently participate in GLOBE. In the United States, GLOBE is managed by the University Corporation for Atmospheric Research and Colorado State University, under sponsorship of NASA, the National Science Foundation and the U.S. Department of State. Other nations administer their own programs.

CONTACT: Phone: 1-800-858-9947, Email: help@globe.gov.

ISS EarthKAM

<http://www.earthkam.ucsd.edu>

ISS EarthKAM is a NASA education program that enables students, teachers and the public to learn about Earth from the unique perspective of space. At the core of the program is a spectacular collection of digital images of Earth. The image collection and accompanying learning guides and activities are extraordinary resources to support classes in Earth science, space science, geography, social studies, mathematics, communications and art.

ISS EarthKAM images are unique because they are taken by middle school students. Using the program's Web site, students request images based upon their classroom investigations. Since the program's inception in 1996, the ISS EarthKAM camera has flown on five Space Shuttle flights

and taken almost 5000 images. Currently, the camera resides on the International Space Station (ISS).

Middle school educators who would like to have their students take photographs with the ISS EarthKAM can quickly and easily register for the program online. Everyone is invited to use and enjoy the photos and educational support materials. ISS EarthKAM is a collaboration among NASA; the University of California, San Diego; Texas A&M; and TERC's Center for Earth and Space Science Education.

CONTACT: Karen Flammer, UCSD EarthKAM, Mail Code 0426, Serf Room 308, 9500 Gilman Dr., La Jolla, CA 92093-0426, **Phone:** 858-534-5827, **Fax:** 858-822-1277, **Email:** ek-help@earthkam.ucsd.edu.

The JASON Project

<http://www.jason.org>

Geared toward grades 4–9, the JASON Project provides experience-based science and math curriculum and professional development. Using multimedia tools and access to the nation's leading scientists, JASON combines genuine scientific expeditions around the world, standards-based classroom curriculum and accredited professional learning for teachers—to deliver real-life adventures in learning and measurable gains in student achievement.

JASON goes from the depths of the ocean to the heights of rainforest canopies and from icy polar regions to red-hot volcanoes, to take students and teachers on an exciting journey that sparks imagination and enhances the classroom experience. JASON's supplementary science curriculum connects students and teachers with researchers in the field and is designed by the world's leading scientists and educators. Teachers are able to integrate JASON's easy-to-use, technology-rich content in ways that work for today's standards-based education environment. Correlated to textbooks, the instructional design incorporates hands-on and inquiry-based learning. JASON is based on national standards for science, math, social studies, language arts and technology and aligned with state standards for science.

JASON supplies everything a classroom needs to create an exciting, experience-based learning adventure:

- Complete curriculum set, including lessons, activities, experiments and teacher's guide;
- Preview videotape with expert scientists;
- Online materials, student activities, math tools and support resources;
- Classroom resources, including reading list and classroom maps;
- Self-assessment exercises allowing students to measure their own performance; and
- Live broadcast of two-week expedition.

JASON is also a leader in innovative professional learning solutions for math and science educators, providing simple and affordable options—all designed to improve instructional strategies. JASON offers online academy courses, face-to-face workshops, on-site modeling and coaching institutes and an annual educators' conference. JASON sites are located throughout the country, including at NASA's Ames Research Center, Goddard Space Flight Center and Johnson Space Center. Programs focus on rainforests, oceans, extreme environments, volcanoes and exploration of inner and outer space.

CONTACT: Phone: 1-888-527-6600, Email: info@jason.org.

Johns Hopkins Earth/Space Science Graduate Studies Program

http://www.mdspacegrant.org/ssip_about.html

The Maryland Space Grant Consortium, in collaboration with the Johns Hopkins University Graduate Division of Education, offers graduate course work in Earth/space science that may be used toward a "Graduate Certificate in Earth/Space Science" or a "Master of Science in Education: Educational Studies with Concentration in Earth/Space Science" from Johns Hopkins University.

Open to elementary, middle and high school teachers in mathematics, science, physics, environmental science, social studies or geography, the program fosters collaboration among Johns Hopkins, NASA's Goddard Space Flight Center, the Maryland State Department of Education and affiliates of the Maryland Space Grant Consortium. See Web site for complete information, including course requirements and financial assistance.

CONTACT: Anne Anikis, Assistant Director, Maryland Space Grant Consortium, The Johns Hopkins University, 203 Bloomberg Center for Physics and Astronomy, 3400 N. Charles St., Baltimore, MD 21218-2686, Phone: 410-516-7106, Fax: 410-516-4109, Email: anne@pha.jhu.edu.

Learning Technologies Project (LTP)

<http://education.nasa.gov/ltp>

The Learning Technologies Project (LTP) is NASA's educational technology incubator. This effort funds and collaborates with activities that join NASA content with emerging technologies and innovative use of entrenched technologies—to inspire students to pursue careers in science, math, engineering and technology. LTP nurtures and partners with the entrepreneurial talents of government, industry, academia, nonprofits and NASA enterprises to develop educational technology that enables learners of diverse

backgrounds, characteristics and abilities. LTP supports the widest possible dissemination of educational technology that engages the learner in compelling scientific and mathematical concepts using NASA data.

Periodically, LTP solicits and awards several grants and cooperative agreements to organizations outside of NASA through the LEARNERS (Leading Educators to Applications, Research and NASA-related Educational Resources in Science) project.

CONTACTS: Patrick Hogan, LTP Deputy, NASA Ames Research Center, Phone: 650-604-5656, Email: Patrick.Hogan@nasa.gov; Susan Hoban, Learners Project Coordinator, NASA Goddard Space Flight Center, Phone: 301-286-7980, Email: susan.hoban@gsfc.nasa.gov

Mathematics of the Great Dismal Swamp Project

<http://nia.ecsu.edu/nrts/ess/mds/mds.html>

The Mathematics of the Great Dismal Swamp Project supports a team of professors from Elizabeth City State University, using research on the Great Dismal Swamp as a platform for development of mathematics education lessons that incorporate a generic wetlands application. Four new modules will be developed, all of which include an interdisciplinary approach for incorporating Earth system science into K–12 courses. Lessons will be produced on lithographs, postcards, CD-ROMs and posters.

CONTACT: Linda Hayden, NASA Network Resources and Training Site, Elizabeth City State University, Box 672, 1704 Weeksville Rd., Elizabeth City, NC 27909, Phone: 252-335-3696, Fax: 252-335-3790, Email: lhayden@umfort.cs.ecsu.edu.

Measuring Vegetation Health

The health of a plant can be readily determined by measuring the relative intensity of visible and infrared light reflected from its leaves and by studying changes in plant growth. This project will use a series of six technologies to measure the intensities of reflected light and the growing patterns of plants: light-emitting diode (LED) connected to a voltmeter; ALTA II reflectance spectrometer; a digital camera with filters; a camera flown on a kite or weather balloon; a hyperspectral camera flown on airplanes; and the remote-sensing software, MultiSpec.

The sequential use of these technologies is designed to focus on the local environment, first at very small scales, then with increasing spatial coverage. Through the use of these technologies, middle and high school students become familiar with the principles of light, reflection,

transmission, color, plants, photosynthesis and remote-sensing measurements, as well as with the local surface cover in the imagery. Students also learn about the strengths and limitations of individual measurement technologies and realize the need for integrating multiple perspectives into scientific studies.

The “Measuring Vegetation Health” series will be integrated into both the Global Systems Science curriculum (<http://www.lawrencehallofscience.org/gss>), created by the Lawrence Hall of Science at the University of California, Berkeley, and into the activities of the University of New Hampshire’s Forest Watch program (<http://www.forestwatch.sr.unh.edu>). The integrated series will be available as a stand-alone unit that may be incorporated by teachers when needed, as a yearlong curriculum or as activities for use by museums, science centers, arboretums and botanical gardens.

CONTACT: John Pickle, Program Manager for Global Systems Science, Museum of Science, Science Park, Boston, MA 02114-1099, **Phone:** 617-589-0436, **Fax:** 617-589-0389, **Email:** jpickle@mos.org.

Minority University-Space Interdisciplinary Network (MU-SPIN)

<http://muspin.gsfc.nasa.gov>

NASA created MU-SPIN to help train the next generation of NASA’s minority scientists and engineers. The program has remained a highly effective tool throughout its growth and evolution over the past decade. MU-SPIN serves America’s Historically Black Colleges and Universities (HBCUs) and Other Minority Universities (OMUs), which include Hispanic Serving Institutes (HSIs) and Tribal Colleges and Universities (TCUs).

The first step for the MU-SPIN program was to provide network infrastructure by helping minority schools to purchase, and even build, computers for the classroom. During its next phase, MU-SPIN established Network Resources and Training Sites (NRTSs), allowing the program to expand and target a larger minority community of students, faculty, administrators and community members. Next, MU-SPIN established Expert Institutes to help foster scientific curriculum development and research with the goal of increasing participation in NASA-related science, especially Earth science. MU-SPIN also created the Institutes for Collaborative Research and Education (ICRE) model to further promote NASA science and technology in minority schools.

CONTACT: James Harrington, MU-SPIN Project Manager, Code 933, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-286-4063, **Fax:** 301-286-1775, **Email:** james@muspin.gsfc.nasa.gov.

NASA Earth Science Missions—Education Programs and Resources

Many of NASA’s Earth science missions have an education and/or public outreach component. These efforts include a wide variety of activities and resources for educators, students and the public, including teacher workshops, public programs and events and curriculum and classroom materials in the form of CD-ROMs, posters, brochures and videos. Visit the Web sites listed with each mission for specific information on a mission’s programs and resources, including access to satellite imagery and other data. Missions are listed by year of launch or scheduled launch.

TOPEX/Poseidon

<http://sealevel.jpl.nasa.gov/education/education.html>

Jointly sponsored by NASA and CNES, the French space agency, the TOPEX/Poseidon satellite uses radar altimeters to continuously survey ocean surface height. The Jason-1 satellite joined TOPEX/Poseidon in orbit in 2001 to collect similar data.

Scientists are using TOPEX/Poseidon and Jason-1 data to learn more about global ocean circulation patterns, including phenomena such as El Niño/La Niña. Oceans are a key mechanism in transporting heat from the Sun around the globe. Researchers are working to improve understanding of the role oceans play in controlling seasonal variations and longer-term climate changes. Ocean altimetry data are also used for operational purposes, including ship routing, fisheries management, hurricane forecasting and support of underwater activities like cable laying.

CONTACTS: Annie Richardson or Mona Jasnow, Jet Propulsion Laboratory, **Email:** topex@jpl.nasa.gov. (Launched: 1992)

SeaWiFS

<http://seawifs.gsfc.nasa.gov/SEAWIFS/TEACHERS>

The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) is providing quantitative data on global ocean bio-optical properties. Subtle changes in ocean color signify various types and quantities of marine phytoplankton (microscopic marine plants), the knowledge of which has both scientific and practical applications. SeaWiFS has helped us to not only monitor the short-term spatial and temporal variability in the ocean’s biology, but also to have the first well-calibrated, long-term data set that allows us to quantify the ocean’s biological response to global change. (Launched: 1997)

Tropical Rainfall Measuring Mission (TRMM)

<http://trmm.gsfc.nasa.gov>

<http://strategies.org/TRMM.html>

TRMM is a joint mission between NASA and the National Space Development Agency of Japan (NASDA). It was designed to monitor and study tropical rainfall and the associated release of energy that helps to power the global atmospheric circulations shaping both weather and climate around the world.

CONTACT: Jeffrey Halverson, TRMM Education and Outreach Scientist, Code 912, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6333, **Email:** halverson@agnes.gsfc.nasa.gov. (Launched: 1997)

ACRIMSAT

<http://acrim.jpl.nasa.gov/education/eduindex.html>

Using the Active Cavity Radiometer Irradiance Monitor (ACRIM) III instrument, the ACRIMSAT spacecraft provides long-term, precise measurements of the total amount of the Sun's energy that falls on our planet's surface, oceans and atmosphere. ACRIM I was the first instrument to clearly show that the energy from the Sun is not a constant value but instead varies over time. These energy changes are small but significant, and they cycle approximately every 11 years. ACRIMSAT data is vital to helping scientists build more accurate climate models. (Launched: 1999)

Landsat 7

<http://landsat.gsfc.nasa.gov/main/education.html>

The Landsat 7 satellite is acquiring remotely sensed images of land surface and coastal regions for global change research, regional environmental change studies, national security uses and other civil and commercial purposes. The Landsat 7 data set will provide the first high-resolution view of both seasonal and interannual changes in the terrestrial environment.

CONTACT: Stephanie Stockman, Code 921, NASA Goddard Space Flight Center, **Phone:** 301-614-6457, **Email:** stockman@core2.gsfc.nasa.gov. (Launched: 1999)

SeaWinds on QuikSCAT

<http://winds.jpl.nasa.gov/education>

The SeaWinds instrument on the QuikSCAT satellite is a "quick recovery" effort to fill the gap created by the loss of data from the NASA Scatterometer (NSCAT) when the satellite lost power in June of 1997. SeaWinds is a specialized microwave radar that measures near-surface wind speed and direction over the Earth's oceans under all weather and cloud conditions.

CONTACT: Peter Falcon, Scatterometer Projects Outreach Coordinator, Jet Propulsion Laboratory, 4800 Oak Grove Dr., MS TR 1722-114, Pasadena, CA 91109-8099, **Phone:** 818-393-0729, **Fax:** 818-354-8813, **Email:** pcfalcon@pop.jpl.nasa.gov. (Launched: 1999)

Terra

<http://terra.nasa.gov>

Terra, the flagship satellite of NASA's Earth Observing System, is collecting what will ultimately become a new, 15-year global data set on the state of the land, oceans and atmosphere. Data from this mission are used in many research and commercial applications.

CONTACT: David Herring, Code 913, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6219, **Email:** dherring@climate.gsfc.nasa.gov. (Launched: 1999)

EO-1

<http://eo1.gsfc.nasa.gov/Education/eo1Education.html>

Earth Observing-1 (EO-1) is the first flight of NASA's New Millennium Program (NMP). Its mission is to validate technologies that will reduce the cost and increase the capabilities of upcoming land-imaging missions. As a result of EO-1, future spacecraft will be an order of magnitude smaller and lighter than current versions.

CONTACT: Joseph Young, EO-1 Mission Technology Transfer Manager, NASA Goddard Space Flight Center, **Phone:** 301-286-8146, **Email:** joseph.p.young.1@gsfc.nasa.gov. (Launched: 2000)

Jason-1

<http://sealevel.jpl.nasa.gov/education/education.html>

Jointly sponsored by NASA and CNES, the French space agency, Jason-1 is a follow-on mission to TOPEX/Poseidon. See TOPEX/Poseidon listing (p. 10) for additional details. (Launched: 2001)

SAGE III/METEOR-3M

<http://www-sage3.larc.nasa.gov/solar>

The Stratospheric Aerosol and Gas Experiment (SAGE) III mission on the Russian Meteor-3M spacecraft seeks to enhance our understanding of natural and human-derived atmospheric processes—by providing high-latitude, long-term measurements of the vertical structure of aerosols, ozone, water vapor and other important trace gases in the upper troposphere and stratosphere. Student's On-Line Atmospheric Research (SOLAR) is the education and outreach component of SAGE III.

CONTACT: David Woods, NASA Langley Research Center, Hampton, VA 23681, **Email:** d.c.woods@larc.nasa.gov. (Launched: 2001)

Aqua

<http://aqua.nasa.gov>

Latin for "water," Aqua is named for the large amount of information the mission is collecting about the Earth's water cycle, including evaporation from the oceans, water vapor in the atmosphere, clouds, precipitation, soil moisture, sea ice, land ice and snow cover on land and ice. Additional variables also being measured by Aqua include radiative energy fluxes, aerosols, vegetation cover on land, phytoplankton and dissolved organic matter in the oceans and air, land and water temperatures.

CONTACTS: Claire Parkinson, Code 971, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-5715, **Email:** claire.l.parkinson@nasa.gov; Steve Graham, Code 900, NASA Goddard Space Flight Center, **Phone:** 301-614-5561, **Email:** steven.m.graham.2@gsfc.nasa.gov. (Launched: 2002)

GRACE

<http://www.csr.utexas.edu/grace/education>

The second of the Pathfinder missions, the Gravity Recovery and Climate Experiment (GRACE) employs a satellite-to-satellite microwave tracking system to measure the Earth's gravity field and its variability over time. Such measurements are directly coupled to long-wavelength ocean circulation processes and to the transport of ocean heat to the Earth's poles.

CONTACT: **Email:** grace_edu@tsgc.utexas.edu. (Launched: 2002)

SeaWinds on ADEOS II

<http://winds.jpl.nasa.gov/education>

The Advanced Earth Observing Satellite (ADEOS) II is a joint mission with the National Space Development Agency of Japan (NASDA). The SeaWinds scatterometer is a specialized microwave radar that measures near-surface wind velocity (both speed and direction) over the Earth's oceans under all weather and cloud conditions.

CONTACT: Peter Falcon, Scatterometer Projects Outreach Coordinator, Jet Propulsion Laboratory, 4800 Oak Grove Dr., MS TR 1722-114, Pasadena, CA 91109-8099, **Phone:** 818-393-0729, **Fax:** 818-354-8813, **Email:** pcfalcon@pop.jpl.nasa.gov. (Launched: 2002)

ICESat

<http://icesat.gsfc.nasa.gov/publicoutreach.html>

The Ice, Cloud and Land Elevation Satellite (ICESat) operates the Geoscience Laser Altimeter System (GLAS), which accurately measures the elevation of the Earth's ice sheets, clouds and land. Data is available from the National Snow and Ice Data Center: <http://nsidc.org/daac/icesat>.

CONTACT: **Email:** webmaster@icesat0.gsfc.nasa.gov. (Launched: 2003)

SORCE

http://lasp.colorado.edu/sorce/edu_outreach.html

The Solar Radiation and Climate Experiment (SORCE) mission is providing state-of-the-art measurements of incoming x-ray, ultraviolet, visible, near-infrared and total solar radiation. The measurements provided by SORCE specifically address long-term climate change, natural variability and enhanced climate prediction, as well as atmospheric ozone and UV-B radiation. These measurements are critical to studies of the Sun and its effect on the Earth system.

CONTACT: Gary Rottman, Laboratory for Atmospheric and Space Physics, Campus Box 590, University of Colorado, Boulder, CO 80309-0590, **Phone:** 303-492-8324, **Email:** gary.rottman@lasp.colorado.edu. (Launched: 2003)

Aura

<http://aura.gsfc.nasa.gov/outreach>

Aura will study the Earth's ozone, air quality and climate. The mission is designed exclusively to conduct research on the composition, chemistry and dynamics of the Earth's upper and lower atmosphere.

CONTACT: Stephanie Stockman, Code 921, NASA Goddard Space Flight Center, **Email:** stockman@core2.gsfc.nasa.gov. (Scheduled launch: 2004)

GIFTS

<http://tellus.ssec.wisc.edu/outreach/gifts/gifts.htm>

The Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS) will make revolutionary advances in weather observations and potentially improve weather forecasts—by making vertical and horizontal measurements of winds, water vapor and temperature in the Earth's atmosphere from a geosynchronous orbit.

CONTACT: Arlene Levine, NASA Langley Research Center, Hampton, VA 23681-0001, **Phone:** 757-864-3318, **Email:** a.s.levine@larc.nasa.gov. (Scheduled launch: 2005)

CALIPSO

<http://www-calipso.larc.nasa.gov/outreach>

The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite will produce the first global three-dimensional view of aerosols and clouds. It will improve our understanding of the role aerosols and clouds play in the processes that govern climate responses and feedbacks, and improve the representation of aerosols and clouds in models, leading to more accurate predictions of climate change. Accurate climate model predictions will provide international and national leaders with reliable information to make more informed policy decisions about global climate change. CALIPSO will fly in formation with Cloudsat (see next listing) and other satellites.

CONTACTS: Dianne Robinson, Outreach Director for CALIPSO, Interdisciplinary Science Center (ISC), Hampton University, **Email:** dianne.robinson@hamptonu.edu; Barbara Maggi, Assistant Outreach Director for CALIPSO, Center for Atmospheric Sciences (CAS), Hampton University, **Email:** barbara.maggi@hamptonu.edu. (Scheduled launch: 2005)

CloudSat

<http://cloudsat.atmos.colostate.edu/outreach>

CloudSat will provide vertical profiling from space of the full range of clouds, from thin cirrus to thick, precipitating convective clouds. It will also provide the first quantitative estimates of ice in clouds. The mission will fill a critical gap in the investigation of feedback mechanisms linking clouds to climate. CloudSat will orbit in formation as part of a constellation of satellites including Aqua, Aura and CALIPSO. One of the unique features that CloudSat brings to this constellation is the ability to fly a precise orbit, enabling the footprint of the CloudSat radar to be overlapped with that of the CALIPSO lidar, as well as with other instruments in the constellation. The precision of this overlap creates a unique multi-satellite observing system for studying atmospheric processes essential to the hydrological cycle.

CONTACT: Debra Krumm, Outreach Coordinator, Department of Atmospheric Science, Colorado State University, Fort Collins, CO 80523-1371, **Phone:** 970-491-8790, **Email:** dkrumm@atmos.colostate.edu. (Scheduled launch: 2005)

NASA Explorer Schools

<http://explorerschools.nasa.gov>

NASA's challenging and exciting missions provide unique opportunities for engaging and educating the nation's youth. Each year, the NASA Explorer Schools (NES) program establishes a three-year partnership between NASA and 50 school teams consisting of teachers and education administrators. The program focuses on underserved populations in diverse geographic locations from across the country.

While partnered with NASA, NES teams acquire and use new teaching resources and technology tools for students in grades 4–9. Schools in the program are eligible to receive funding (pending budget approval) over the three-year period to purchase technology tools that support science and mathematics instruction.

The NES program provides:

- Customized professional development for teachers and administrators;

- Authentic NASA science and technology investigations for students; and
- Special events opportunities for families.

A competitive application and selection process for NES teams occurs each spring. See Web site for program and application details.

CONTACT: Peggy Steffen, **Email:** psteffen@nasa.gov.

NASA GISS Institute on Climate and Planets (ICP)

<http://icp.giss.nasa.gov>

ICP is a research, science education and minority outreach program at NASA's Goddard Institute for Space Studies (GISS). ICP engages students in grades 9–16 and teachers of grades 7–12 in Earth science research alongside world-class scientists. ICP is the GISS response to a national, state and local movement for scientific institutions to share in the responsibility of providing young people with the highest quality science, mathematics and technical education. Its overall goal is to increase the pool of interested and academically qualified underrepresented minorities in the pipeline who are successfully completing high school science programs and baccalaureate programs in science, engineering and mathematics.

Through direct research experiences focusing on Earth's climate, ICP seeks to help students develop:

- Views of a world connected regionally and globally;
- Problem-solving skills; and
- Knowledge about the Earth system as it relates to science, technology and society.

Students and educators work on-site or remotely with scientists to create new knowledge that may help us better understand and predict Earth's climate. After-school research internships are available at GISS and cooperating universities. During school, ICP faculty members involve students in new or enhanced curriculum to develop climate change science literacy. Full-time summer enrichment programs offer a more intensive research experience. In-service and pre-service teacher workshops are also conducted to share curriculum. Several ICP spin-off programs are also available as a result of faculty-scientist collaborations.

CONTACT: Carolyn Harris, ICP Director, GISS at Columbia University, 2880 Broadway at 112th St., New York, NY 10025, **Phone:** 212-678-5653, **Fax:** 212-678-5552, **Email:** charris@giss.nasa.gov.

NASA Satellites Study Earth's Atmosphere: CALIPSO, CloudSat and Aura Working with the GLOBE Project <http://137.198.62.160:8080/co2004.html>

CALIPSO, CloudSat and Aura are three satellite-based research missions that will provide students worldwide with a link to NASA research through education and outreach programs. Each of these satellites is scheduled to be included in a formation of six satellites known as the Afternoon Satellite Constellation, also known as the "A-Train." The satellites composing the A-Train will fly in close proximity, providing combined, detailed observations about the condition of Earth and assisting scientists with making predictions related to climate change.

An educator workshop titled "NASA Satellites Study Earth's Atmosphere: CALIPSO, CloudSat and Aura working with the GLOBE Project" is scheduled for July 12–22, 2004, in Fort Collins, Colorado. This workshop primarily targets middle school educators who will work with these three missions to involve students in reporting visual cloud observations and Sun photometer data collection through the GLOBE project Web site. Accepted participants will receive both a stipend and travel expenses. Support will be provided to participants to develop and present at regional workshops within their local school systems. Applications are due February 15, 2004, and are available online.

CONTACTS: CALIPSO: Barbara Maggi, Hampton University, **Email:** barbara.maggi@hamptonu.edu, **Web:** <http://www-calipso.larc.nasa.gov/outreach>; CloudSat: Sue Lini, Colorado State University, **Email:** lini@atmos.colostate.edu, **Web:** <http://cloudsat.atmos.colostate.edu/outreach.html>; Aura: Stephanie Stockman, NASA Goddard Space Flight Center, **Email:** stockman@core2.gsfc.nasa.gov, **Web:** <http://aura.gsfc.nasa.gov/outreach>.

NASA Student Involvement Program (NSIP) <http://education.nasa.gov/nsip>

NSIP is NASA's national program of annual science competitions for K–12 students. Competitions include the Aerospace Technology Engineering Challenge; Design a Mission to Mars...and Beyond; My Planet, Earth; Science and Technology Journalism; Space Flight Opportunities; and Watching Earth Change. NSIP links students directly with NASA's diverse and exciting missions of research, exploration and discovery. The competitions foster student literacy in science, mathematics, engineering, technology and geography. Teachers use NSIP to support curriculum goals, spark student interest, encourage creative thinking across disciplines and involve students in science process skills.

Competition entries are due each January. All qualified entrants receive NASA certificates of participation. For each competition, a winner is selected for each NASA Center. Prizes include medals, plaques, NASA presentations at schools, Space Camp scholarships, trips to the National Symposium and/or Student Flight Week and experiments launched aboard the Space Shuttle or a NASA rocket. The Institute for Global Environmental Strategies awards the (independent) \$4,000 Thacher Scholarship to a first-place, high-school winner in the Watching Earth Change competition. Entry packets, resource guides for each competition and additional program information are available on the Internet at <http://education.nasa.gov/nsip>, by phone or by email.

CONTACT: Phone: 1-800-848-8429, Email: info@nsip.net.

National Space Grant College and Fellowship Program (NSGCFP) <http://www.bq.nasa.gov/spacegrant>

NSGCFP funds support graduate and undergraduate students throughout the continental United States and Puerto Rico. The criteria for recruitment and selection are determined by the Space Grant consortia. However, all must be U.S. citizens and enrolled in a full-time degree program related to aerospace, which includes aeronautics, Earth and space science, space engineering and related fields. Designated Space Grant institutions provide specialized training and education programs to help maintain the nation's capabilities in aerospace science, technology and education and to capitalize on the multiple opportunities afforded by the space environment.

Each state consortium is challenged to:

- Establish a national network of universities with interests and capabilities in aeronautics, space and related fields;
- Encourage cooperative programs among universities, aerospace industry and federal, state and local governments;
- Encourage interdisciplinary training, research and public service programs related to aerospace;
- Recruit and train professionals—especially women, underrepresented populations and persons with disabilities—for careers in aerospace science and technology; and
- Promote a strong science, mathematics and technology education base from elementary through secondary school levels.

CONTACT: See Web site to connect to the NASA Space Grant institution in your state.

Near Earth Achievable Remote Sensing (NEARS)

<http://www.edu.ssc.nasa.gov/erc/nears.htm>

Through educator workshops provided by the NASA Educator Resource Center at NASA's Stennis Space Center, NEARS introduces teachers to a low-cost method of capturing and using aerial images. The workshops show teachers how to build camera platforms using inexpensive foam and disposable cameras, and how to loft the platforms using kites or helium-filled balloons. Teachers also receive a set of hands-on activities designed to engage students in learning the fundamentals of remote sensing.

CONTACT: Stennis Space Center Educator Resource Center, **Phone:** 1-800-237-1821 (select option 2).

Odyssey of the Mind

<http://www.odysseyofthemind.com>

<http://earthobservatory.nasa.gov/odysseyofthemind>

NASA is partnering with Odyssey of the Mind to develop and sponsor a long-term Earth science problem for their annual competition. Founded in 1978, Odyssey of the Mind, an international creative problem-solving program for students from kindergarten through college, attracts students from across the United States and more than 30 other countries. Odyssey of the Mind competitions involve creative exercises in which teamwork, cooperation and ingenuity are applied to complete various tasks. Students choose from one of six long-term "problems" and form teams to develop solutions. The problems range in nature from the technical to the artistic, and solutions are judged for creativity, originality and other criteria. In the spring, teams take their solutions to official competitions at the regional, state, country and world level.

The NASA-sponsored problem for the 2003–04 competition is "Strategy Sphere," which requires teams to design and build two devices that will mechanically propel balls through a circular hoop. Teams will also create a device to retrieve the balls after they are launched. All aspects of the problem solution will be integrated into a theme about how a change in the Earth's geosphere affects the Earth's atmosphere.

CONTACT: For more information, visit the main Odyssey of the Mind Web site or NASA's Odyssey of the Mind Web site.

PIPELINES

<http://www.phys.subr.edu/pipelines>

PIPELINES, the Program to Increase the Pursuit of Education and Learning In Engineering and Science, is a partnership between Southern University and A&M College in Baton Rouge (SUBR) and Iowa State University (ISU). The program supports activities in Earth and environmental science for K–12 students and teachers, undergraduates, graduates and university faculty. Major components of the program include:

- **Educational reform workshops**—Both SUBR and ISU offer in-service workshops for pre-college teachers and college faculty designed to promote and support standards-based education, with an emphasis on science and mathematics in general and Earth and environmental science in particular. In addition, the SUBR College of Education's Curriculum Center holds regular workshops to aid teachers in preparing meaningful lessons and activities for students, and serves as a statewide repository for instructional materials and supplies for teachers in science and mathematics.
- **GLOBE certification training**—GLOBE is a worldwide network of K–12 students who, under the guidance of trained teachers, make a core set of environmental observations and report their data via the Internet. SUBR provides training for teachers in the basic GLOBE protocols for collecting data. Participating teachers receive GLOBE materials and supplies, as well as stipends for attending after-school, weekend or holiday sessions.
- **Undergraduate research support**—PIPELINES sponsors 20 high-achieving undergraduate students in science, mathematics and engineering to conduct Earth science research at NASA Centers, SUBR or ISU.
- **Earth Science at the Timbuktu Academy (ESTA)**—ESTA is a six-week residential program at SUBR's Timbuktu Academy designed to enhance the academic achievements of pre-college students, including the improvement of SAT/ACT scores. Students are exposed to Earth science education, research and career opportunities. College matriculation in Earth science-related fields is a major objective.
- **Science Bound**—The goal of this ISU program is to increase the number of underrepresented students who enter science and technology careers by shaping their academic preparedness, self-confidence and overall attitudes.

CONTACTS: Diola Bagayoko, Program Director, **Phone:** 225-771-2730, **Fax:** 225-771-4341, **Email:** bagayoko@aol.com; Monika Wright, Assistant to the Director, **Phone:** 225-771-2730, **Fax:** 225-771-4341, **Email:** mwright773@aol.com.

Practical Uses of Math And Science (PUMAS)

<http://pumas.jpl.nasa.gov>

PUMAS is an online journal of brief examples illustrating how math and science concepts taught in the K–12 classroom are used in everyday life. PUMAS offers a way for researchers to make a substantial contribution to education with a relatively small investment of time and effort. Examples may be activities, anecdotes, descriptions of “neat ideas,” formal exercises, puzzles or demonstrations, written primarily by scientists in any style that serves the material well. They are intended mainly to help teachers enrich their presentation of science and math in the classroom.

The examples are available to everyone via the PUMAS Web site. The collection can be searched based on curriculum topic, grade level or subject. All examples are peer-reviewed by at least one scientist with a relevant background and at least one teacher at an appropriate grade level. Once accepted, an example is a citable reference in a refereed science education journal and may be listed in the author’s resume. PUMAS is always looking for new contributions and reviewers.

CONTACT: Ralph Kahn, Editor, Jet Propulsion Laboratory, 4800 Oak Grove Dr., MS 169-237, Pasadena, CA 91109, **Phone:** 818-354-9024, **Fax:** 818-393-4619, **Email:** ralph.kahn@jpl.nasa.gov.

Project 3D-VIEW

<http://www.3dview.org>

Project 3D-VIEW (Virtual Interactive Environmental Worlds) is a Web- and curriculum-based classroom program for upper elementary and middle schools. The program combines NASA data and three types of 3D learning technologies in a curricular materials package for student explorers using 3D viewers and the Internet. Designed primarily for grades 5 and 6, Project 3D-VIEW will create a virtual “tele-presence” for students in each of the Earth’s spheres—biosphere, geosphere, hydrosphere, atmosphere and cryosphere. Additionally, a module introducing Earth systems will be available for older or more experienced students.

A major goal of the project is to prepare students for Earth system science courses in high school and beyond by making them experts in each sphere. Using simple Web interfaces, students will explore, create, manipulate and navigate 3D VRML (Virtual Reality Modeling Language) views. The three basic components of the Project 3D-VIEW classroom program are:

- Hands-on activities and content instruction;
- Image visualization and interpretation and manipulation of Earth and digital elevation data for combined spheres; and
- Real-world explorations (local and broad-based) and scenarios that are coupled with student research and analysis and scientist feedback.

An on-site/online teacher professional development program will certify over 1,200 teachers. Partners include four large urban school districts serving underrepresented student populations and Stanford University. Classroom strategies and assessment will be implemented for mathematics and science. Curricular activities developed will meet national standards in science, geography, mathematics and technology. Interested schools should inquire about participating in the beta programming.

CONTACT: Glen Schuster, Director, U.S. Satellite Laboratory, 505 White Plains Rd., Tarrytown, NY 10591, **Phone:** 914-332-8566, **Email:** gschuster@signals.ofspring.net.

Project ESCAPE

Project ESCAPE (Eager Student Community Activism for Planet Earth) is an interdisciplinary program for pre-college students focusing on Earth science and using satellite imagery as a learning resource. Additionally, Project ESCAPE provides courses on college readiness and career awareness in the field of Earth sciences.

The program supports the NASA mission of preparing underrepresented students for mathematics, science and technology courses and for careers in these areas. The program goals are to:

- Demonstrate the relevance of Earth science subject matter to the lives of students;
- Actively engage students and present science as a process;
- Give students an understanding of remote-sensing technology;
- Empower students with the skills and knowledge to study the environment in their own communities; and
- Provide students with experience in using computers as learning tools.

Students are exposed to an Earth science curriculum supported by NASA materials and are provided opportunities to attend educational and scientific field trips, such as the Smithsonian’s Air and Space Museum, an overnight camping experience, the Naval Research Lab, the Discovery Channel and the Foundation Chesapeake Bay.

Contact: Elaine Bourne Heath, Dean, Faculty and Academic Affairs, Southeastern University, 501 I St., SW, Washington, DC 20024, **Phone:** 202-478-8264, **Fax:** 202-484-8337; **Email:** eheath@admin.seu.edu.

Sensing Cape Cod

http://www.nps.gov/caco/resources/CACO_LC/outreach.htm

Sensing Cape Cod is a pilot project in which NASA Earth science data and remote-sensing technology are used to teach environmental and Earth sciences in concert with the ongoing educational and research efforts in a national park. Science teachers are teaming with Cape Cod National Seashore researchers to develop a middle and high school level coastal ecosystem curriculum unit to monitor local ecological change.

Connections between the responses of local coastal ecosystems to environmental processes and human activities will be made so that teachers and students will have a greater understanding of Earth system science and how climate change is affecting Cape Cod. Project partners include NASA, the National Park Service and the U.S. Geological Survey. Project goals are to:

- Inspire and educate the next generation by providing students with effective and exciting learning opportunities about the application of NASA research and technology at national parks;
- Enable and encourage teachers to use NASA science, technology and educational tools in a national park context; and
- Create a venue for educators, students and scientists to use national parks as laboratories for scientific research and learning.

CONTACTS: Anita Davis, NASA Goddard Space Flight Center, Code 923, Greenbelt, MD 20771, **Email:** adavis@pop900.gsfc.nasa.gov; Nancy Finley, Chief of Natural Resources, Cape Cod National Seashore, 99 Marconi Site Rd., Wellfleet, MA 02667, **Phone:** 508-349-3785, ext. 216, **Fax:** 508-349-9052, **Email:** nancy_finley@nps.gov.

Students' Cloud Observations On-Line (S'COOL)

<http://scool.larc.nasa.gov>

S'COOL is a component of NASA's Clouds and the Earth's Radiant Energy System (CERES) project. CERES is an instrument onboard several NASA satellites that measures the amount of energy reflected and emitted by clouds. S'COOL participants make "ground-truth" measurements—land-based observations that are used to validate and improve satellite measurements.

Participating students are asked to make basic weather observations and to record the type and features of clouds in the sky at the time the satellite is scheduled to pass over their location. The data is then submitted online or sent by email, fax or regular mail to NASA for entry into an online database. Students can access their results as well as those from other participating schools using the S'COOL Web site. Satellite observations for matching times are also posted so that students can compare their observations to the those of the satellite, and NASA scientists can evaluate the performance of the CERES instrument.

Participants receive instructional materials, a schedule of satellite overpass times and information necessary for reporting results. There is no cost to participate. A week-long workshop is held each summer at NASA's Langley Research Center, allowing participating teachers to obtain an in-depth understanding of related scientific issues. See Web site for registration information.

CONTACT: Attn: S'COOL, Mail Stop 420, NASA Langley Research Center, Hampton, Virginia 23681-2199, **Phone:** 757-864-5682, **Fax:** 757-864-7996, **Email:** scool@larc.nasa.gov.

Summer High School Apprenticeship Research Program (SHARP)

<http://www.mtsibase.com/ssharp>

NASA SHARP is designed for students who have demonstrated a strong interest in and aptitude for science, technology, engineering, mathematics and geography (STEM+G). One of the program's objectives is to encourage the career paths of pre-college students who have been traditionally underrepresented in STEM+G fields—females, African Americans, Native Americans, Hispanics, Pacific Islanders (natives of the Philippines, Guam, American Samoa and Micronesia) and the disabled. The NASA SHARP "Commuter Component" is conducted at 13 participating NASA field centers, while the "Residential Component" is conducted at universities throughout the United States.

Each year, approximately 400 students are selected to participate in NASA SHARP for a minimum of eight weeks during the summer. Some of NASA's top science professionals, while conducting cutting-edge research as well as working on state-of-the-art equipment, mentor qualified students. One of NASA's primary goals is to strengthen the agency's and nation's ability to recruit and sustain a more diverse workforce by preparing students for careers in STEM+G fields.

CONTACT: For more information on the Commuter Component of NASA SHARP, please write to the NASA field center of interest (a list is provided on the SHARP Web site). For more information on the Residential Component, or for information about NASA SHARP at the national level, please contact the program manager at: Modern Technology Systems, Inc. (MTSI), 6801 Kenilworth Ave., Suite 200, Riverdale, MD 20737-1331, **Phone:** 301-985-5171, **Fax:** 301-985-5176, **Email:** info@nasasharp.com.

Tropical Center for Earth and Space Studies (TCESS)

<http://tcess.uprm.edu>

The TCESS at the University of Puerto Rico at Mayagüez (UPRM) is a NASA University Research Center—a multidisciplinary research unit established at a minority institution to focus on a specific area of NASA interest. The center's education component, GLOBE TEST, is a comprehensive project to align science, environmental education and technology with current state educational reforms. The initiative integrates calculator-based laboratory (CBL) technology, geographic information systems (GIS) techniques and GLOBE protocols to current laboratory and curriculum in chemistry, biology and mathematics.

The overall goal of GLOBE TEST is to transform a significant number of in-service and pre-service teachers into proficient educators in the areas of science and technology. The project's professional development program combines workshops, Saturday academies, follow-up activities and visits to schools, as well as activities for teacher, parent and student involvement. The intensive week-long workshops and Saturday academies allow teachers to become skilled in GLOBE TEST activities through hands-on experience, while follow-up activities bring teachers and their students to UPRM's facilities to integrate GLOBE TEST activities with the K–12 science curriculum.

CONTACT: Miguel Velez-Reyes, Director, Tropical Center for Earth and Space Studies (TCESS), University of Puerto Rico, PO Box 9048, Mayagüez PR 00681, **Phone:** 787-832-2825, **Fax:** 787-832-2485, **Email:** m.velez@icee.org.

Virginia Geospatial Extension Program

<http://www.cnr.vt.edu/gep>

The Virginia Geospatial Extension Program conducts targeted programs that promote the appropriate use of geospatial tools and applications, and integrate geospatial concepts throughout the K–20 educational pipeline. These tools and applications benefit our lives in many ways and include the global positioning system (GPS), geographic information systems (GIS) and using remote-sensing data sources—satellite imagery and aerial photography—to provide innovative perspectives on local, regional, state and national issues. For example, GIS is to support urban planning, homeland security and to facilitate the management of environmental resources, including forests, wetlands, coastal lands and endangered species.

The program is providing K–12 educational outreach in collaboration with the Virginia Space Grant Consortium's OVERspace program, specialized workforce courses and training through Virginia's Community College System and other VSGC member universities, faculty development, and linkages to NASA and other geospatial resources, data and programs. A key component of this program is its participation with Virginia extension agents, through Agriculture and Natural Resource programs and 4-H Youth Educational initiatives, to support the dissemination of information, training and application development at the grassroots level.

The program is sponsored by the VSGC and the Virginia Cooperative Extension, and is co-located at Virginia Tech in the College of Natural Resources and the College of Agriculture/Virginia Cooperative Extension.

CONTACT: John McGee, Geospatial Extension Specialist, 219 Cheatham Hall (0324), Virginia Tech, Blacksburg, VA, 24061, **Phone:** 540-231-2428, **Email:** jmceg@vt.edu.

Visiting Student Enrichment Program (VSEP)

http://gest.umbc.edu/student_opp/2004_vsep.html

VSEP offers students from the high school to graduate level summer internships with the Goddard Earth Sciences and Technology Center (GEST), working with scientists at NASA's Goddard Space Flight Center (GSFC). Students interact with scientists and professionals at a world-class facility, while gaining valuable experience through a project focused primarily on computer science or the application of computers to solve problems in other sciences. VSEP also holds field trips and lectures to broaden appreciation for GSFC's mission and activities. Past student projects have included simulating neural networks, preparing image

analysis algorithms on supercomputers, developing computational science applications, and creating interactive Web sites.

GSFC facilities that offer the internships include:

- **The Scientific Computing Facility**, with its advanced computers (i.e., Cray T3E, Cray SV1's, SGI ORIGIN 2K and ORIGIN 3K, SUN E10000 and E6500, IBM RS 6000 SP), the world's largest UniTree mass storage system, as well as a visualization studio.
- **The National Space Science Data Center**, a central repository for the large databases generated from NASA spacecraft.
- **The Data Systems Technology Division**, which provides a full spectrum of hardware and software environments to support applied research and development of advanced solutions to operational problems.
- **Laboratory for Atmospheres**, which researches areas such as atmosphere modeling and climate analysis in support of Earth observing systems; and
- **Laboratory for Hydrospheric Processes**, which researches the oceanic, cryospheric and hydrologic sciences.

The 2004 VSEP runs from June 7 to August 13 at GSFC in Greenbelt, Maryland. (Subject to housing availability, high school students may need to begin or end later, depending on their academic calendar.) VSEP is open to full-time students in computer science, the physical sciences and mathematics. Participants must be either U.S. citizens or foreign nationals in U.S. schools who are either permanent residents or who possess a valid F-1 or J-1 visa. All selected students will be subject to a pre-employment security background check under current security guidelines. Online applications and instructions can be found at the Web site.

CONTACT: Visiting Student Enrichment Program, Code 900.1, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Email:** vsep@gsfc.nasa.gov.

You Be the Scientist with Satellite Imagery in EZ/EC Communities (YBTS)

<http://nia.ecsu.edu/nrts/ess/ezec/ezec.html>

YBTS is a student enrichment project for six selected middle schools located in the economic empowerment zone/enterprise communities of Portsmouth, Virginia and Halifax, North Carolina. The project is designed to support extra-curricular science activities that will increase awareness and use of GOES weather satellite data. YBTS is helping students meet core Earth science learning objectives and to develop marketable skills in the area of computer technology, while exposing them to a variety of careers available in research, data analysis, applications and computer visualization. The project is conducted through the Minority University-Space Interdisciplinary Network's Network Resources and Training Site at Elizabeth City State University.

CONTACT: Linda Hayden, NASA Network Resources and Training Site, Elizabeth City State University, Box 672, 1704 Weeksville Rd., Elizabeth City, NC 27909,
Phone: 252-335-3696, **Fax:** 252-335-3790,
Email: lhayden@umfort.cs.ecsu.edu.



Higher Education

The ESE is strengthening its involvement with higher education institutions to ensure that NASA can meet future workforce needs in Earth system science research, applications and related fields, and to improve the scientific education of students bound for other professions. NASA-sponsored programs for college and university faculty are designed to enrich their scientific and technical expertise and help them to establish NASA research contacts. These programs include funding opportunities, workshops and working experiences at NASA Centers, as well as Earth system science curriculum development initiatives.

ESE sponsorship of post secondary students includes research opportunities through programs that provide direct financial assistance and fellowships, along with research and training at NASA facilities and universities. These programs provide opportunities for students to gain experience working with researchers, increase their technical skill, and learn firsthand about Earth system science careers and research.

Center for Coastal Zone Assessment and Remote Sensing

Southern University's Center for Coastal Zone Assessment and Remote Sensing (CCZARS) is a NASA University Research Center—a multidisciplinary research unit established at a minority institution to focus on a specific area of NASA interest. The center is supporting NASA's Stennis Space Center's mission by conducting research in the areas of fisheries habitat assessment, coastal change, land use/land cover change and urban sprawl. CCZARS is also developing related education and outreach initiatives:

- Interdisciplinary faculty research teams will develop course modules and provide technical material.
- A "Distinguished Visiting Researcher" position will be created; incumbent will teach and provide research assistance.
- An undergraduate research program, CCZARS Scholars, will be established, and on-site research experiences for undergraduate and graduate researchers will be provided.

- K-12 students will be introduced to fundamental Earth science concepts and encouraged to pursue careers in science, math, engineering and technology.
- Three-day workshops for current industry partners and K-12 teachers will provide training in geographic information systems (GIS) and remote sensing.
- An annual conference on coastal zone assessment and remote sensing will be held.

CONTACTS: Michael Stubblefield, Director, Southern University and A&M College, PO Box 9764, Baton Rouge, LA 70813, **Phone:** 225-771-4724, **Fax:** 225-771-4722, **Email:** mastub@bellsouth.net; Deidre Hardy-Street, Program Manager, Southern University and A&M College, PO Box 9764, Baton Rouge, LA 70813, **Phone:** 225-771-4724, **Fax:** 225-771-4722, **Email:** dhardy1@bellsouth.net.

Center for Hydrology, Soil Climatology and Remote Sensing's (HSCaRS) Undergraduate Summer Enrichment Program

<http://www.aamu.edu/bscars>

The Center for Hydrology, Soil Climatology and Remote Sensing at Alabama A&M University in Huntsville conducts the Undergraduate Summer Enrichment Program, which provides summer research opportunities for undergraduate minority and female students in Earth system science. Interns are selected from a pool of highly qualified student applicants from across the nation. The program features an eight-week period of residence at Alabama A&M University—where students have the opportunity to work with a researcher/mentor from the school or the Global Hydrology Climate Center at the National Space Science and Technology Center, also in Huntsville, on general research areas (e.g., micrometeorology, soil data analysis, hydrologic modeling, geographic information systems, soil hydrology or computer science). Research papers resulting from interns' summer projects have been presented at various national conferences. Posters describing the program are mailed in January. Applications are available on the project Web site and are typically due on March 1.

CONTACT: Phyllis Campbell, HSCaRS Research Center, Alabama A&M University, Normal, AL 35762, **Phone:** 256-372-5075, **Email:** pcampbell@aamu.edu.

Chautauqua Short Courses for College Teachers: 2004 Faculty Development Program

<http://www.chautauqua.pitt.edu/cal.html>

The Chautauqua Short Courses are an annual series of forums in which scholars at the frontiers of various sciences meet intensively for several days with undergraduate science teachers. The series is held at colleges and universities throughout the United States and at selected special sites. These forums provide an opportunity for invited scholars to communicate new knowledge, concepts and techniques directly to college teachers in ways that are immediately beneficial to their teaching. The primary aim is to enable undergraduate teachers in the sciences to keep their teaching current with respect to both content and pedagogy.

NASA's Jet Propulsion Laboratory, the California field center for the Chautauqua Short Courses, is offering the following Earth science-related courses in 2004:

- **Aurora Borealis and Other Arctic Phenomena:**
March 19–21 in Fairbanks, Alaska
- **Alternative Energy and Energy Management:**
June 2–4 in Irwindale, California
- **Giants of Mauna Kea:** June 15–18 in Hilo, Hawaii
- **Teaching Global Climate and Planetary Change to the Non-Science Major:** July 20–23 in Pasadena, California

The courses are for undergraduate science, math and technology teachers and graduate students in the sciences interested in a teaching career. Secondary school teachers will be allowed to take the course on a space-available basis. Prerequisites: None.

CONTACT: Nicholas Error, Director, NSF National Chautauqua Program, University of Pittsburgh, 274 Benedum Hall, Pittsburgh, PA 15261, **Phone:** 412-624-9761, **Fax:** 412-624-9585, **Email:** error@pitt.edu.

Curriculum Improvement Partnership Award (CIPA) Program

<http://www.uncfsp.org/cipa>

CIPA is a program of NASA's Office of Education, administered by the United Negro College Fund Special Programs Corporation (UNCFSP). CIPA provides selected two- and four-year Minority Serving Institutions (MSIs) grant support to strengthen curricula in academic fields and technical programs directly related to the NASA mission. The specific objectives are to increase the quality and quantity of NASA-related science, technology, engineering and mathematics curricula, and to increase the number of minority students

at the pre-college and college levels that study these subjects and pursue careers in NASA-related fields.

The 2003 CIPA awardees with an Earth science focus are:

- **Barber-Scotia College, Concord, NC**
Barber-Scotia Curriculum Improvement Partnership Program
Principal Investigator: Selma Burrell
Email: sburrell@bsc.edu
- **Clinton Junior College, Rock Hill, SC**
The 3 M's—Motivation, Mentoring and Monitoring
Principal Investigator: Elizabeth Reid
Email: ewreid@comporium.net
- **Lincoln University, Jefferson City, MO**
Successful Undergraduates in Courses Connected to Earth System Sciences (SUCCESS)
Principal Investigator: Michael Heard
Email: heardm@lincolnu.edu
- **Los Angeles Valley College, Los Angeles, CA**
Curricula Upgrade and Science Facilities Improvement Project
Principal Investigator: Jacquelyn Hams
Email: hamsje@lavc.edu

CONTACT: Gilbert Knowles, **Phone:** 703-205-7631,
Email: gilbert.knowles@uncfsp.org.

DEVELOP

<http://develop.larc.nasa.gov>

DEVELOP is an initiative that extends NASA Earth science research to local communities. Student teams demonstrate to community leaders prototype applications of NASA Earth science measurements and predictions addressing local policy issues. The program is a year-round activity, with teams located nationwide. High school through graduate students with strong interests in science, technology and policy are encouraged to apply.

DEVELOP students initiate and research projects in response to challenges that communities pose at leadership forums, such as governors' conferences and association meetings. Their final research results are presented as computer-generated visualizations. The activity is student-led, with NASA scientists serving as advisors. The student projects use NASA Earth science mission data and models, and cover all 12 NASA applications of national priority: agricultural efficiency, air quality, aviation safety, carbon management, coastal management, disaster management, ecological forecasting, energy management, homeland security, invasive species, public health and water management.

Each project requires partnerships with the target community to achieve the greatest return on investment.

Students work with industry, nonprofit organizations or local governments to attract long-term technology and education benefits to the community.

In addition to the core Earth science applications projects, students also conduct outreach activities. For the purposes of advanced visualization demonstrations, students constructed a portable visual immersion environment. DEVELOP also supports the federal Computers for Learning Program by establishing Earth science education computer labs in schools nationwide.

CONTACTS: DEVELOP National Program Office, MS 307, NASA Langley Research Center, Hampton, VA 23681-2199, **Phone:** 757-864-3761; **Fax:** 757-864-7890, **Email:** michael.l.ruiz@nasa.gov.
DEVELOP Western Regional Office, MS 239-20, NASA Ames Research Center, Moffett Field, CA 94035-1000, **Phone:** 650-604-3614; **Fax:** 650-604-1088, **Email:** joseph.w.skiles@nasa.gov.

Earth Observatory

<http://earthobservatory.nasa.gov>

NASA's Earth Observatory is an interactive Web-based magazine where the science-attentive public can obtain new satellite imagery and scientific information about our home planet. The focus is on Earth's climate and environmental change. The site is also designed to be useful to public media and educators. Any and all materials published on the Earth Observatory are freely available for re-publication, re-use or re-broadcast (except in rare cases where copyright is indicated).

Visit the Earth Observatory to read feature articles on wide-ranging Earth system science topics, download datasets and images for analysis, read breaking news, learn about current and planned Earth missions, search an online library for reference materials, track natural hazards around the world in near real time, and access interactive experiments and classroom activities.

CONTACT: David Herring, Code 913, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6219, **Email:** dherring@climate.gsfc.nasa.gov.

Earth Science Component for Academic Professional Enhancement (ESCAPE)

<http://tellus.ssec.wisc.edu/outreach/ESCAPE/esc.htm>

This course addresses the professional development needs of upper elementary, middle and high school science teachers in Wisconsin and neighboring states by offering an online Earth system science course in conjunction with the GETWISE project. ESCAPE investigates deforestation, volcanoes, hurricanes and ice shelf disintegration. GETWISE currently features two lecture series, one in Earth system science and another focusing on the solar system.

Two graduate credits are available through the University of Wisconsin-Madison's Department of Atmospheric and Oceanic Sciences upon successful completion of the ESCAPE course.

CONTACT: Margaret Mooney, Office of Space Science Education-Space Science & Engineering Center, University of Wisconsin-Madison, 1225 W. Dayton St., Madison, WI 53706, **Email:** mooney@ssec.wisc.edu.

Earth System Science Education Alliance (ESSEA)

<http://www.cet.edu/essea>

Sponsored by NASA's Earth Science Enterprise, ESSEA is an exciting and innovative professional development program for K-12 teachers. Participating universities, colleges and science education organizations are offering Earth system science online graduate courses to in-service and pre-service educators. The courses use an innovative instructional design model, are delivered over the Internet and feature student-centered, knowledge-building virtual communities. A master teacher and/or Earth system scientist moderate participants, acting as guides and mentors throughout the 16-week courses. The three courses can be viewed at the following sites:

- Elementary School Teachers' Earth System Science Course: <http://www2.cet.edu/ete/bilk4/main.html>
- Middle School Teachers' Earth System Science Course: <http://www2.cet.edu/ete/5-8/main.html>
- High School Teachers' Earth System Science Course: <http://www2.cet.edu/ete/bil912/main.html>

The courses were developed within the Center for Educational Technologies (CET) at Wheeling Jesuit University. ESSEA is a partnership between CET and the Institute for Global Environmental Strategies, with the participation of 18 colleges and universities.

CONTACT: A listing of ESSEA participating universities and contact information, courses and schedules is available at <http://www.cet.edu/essea> (click on the link for "Course Offerings"). Course costs will vary by university. For general program information, contact: Claudia Dauksys, **Phone:** 703-312-0827, **Email:** essea@strategies.org.

Earth System Science Fellowship Program

http://research.bq.nasa.gov/code_y/code_y.cfm

The purpose of NASA's Earth System Science (ESS) Fellowship Program is to ensure continued training of interdisciplinary scientists to support the study of the Earth as a system. Particular emphasis is placed on the applicant's ability and interest in pursuing academic training and research using observations and measurements from NASA's Earth-orbiting satellites. NASA is especially interested in supporting investigations that fulfill a growing need in competencies relating to data assimilation and continuing improvement of remote-sensing techniques. Over 500 Ph.D. and M.Sc. fellowships have been awarded since the inception of the program in 1990, with plans to award up to 50 new fellowships annually.

Students admitted to or enrolled in a full-time M.Sc. or Ph.D. program in Earth system science or related disciplines at accredited U.S. universities are eligible to apply. Awards are made initially for one year and may be renewed annually, based on satisfactory progress as reflected in academic performance and evaluations by the student's faculty advisor, for no more than two additional years.

The deadline for application is typically March 15 of each year; the results are announced by June 30, with an anticipated award date of September 1 of the same year. Applications will be considered for research in any of the six focus areas established by NASA's Earth Science Enterprise: climate variability and change; atmospheric composition; carbon cycle, ecosystems and biogeochemistry; water and energy cycle; weather; and Earth surface and interior. The maximum amount of award is \$24,000 per year.

CONTACT: Earth System Science Fellowship Program, Code YO, NASA Headquarters, Washington, DC 20546, **Phone:** 202-358-0855, **Email:** acrouch@hq.nasa.gov.

ESSE 21: Earth System Science Education for the 21st Century

<http://es21.usra.edu>

Sponsored by NASA and managed by the Universities Space Research Association, ESSE 21 offers small grants to colleges and universities to encourage collaboration among educators and scientists in the development of Earth system science courses, curricula and degree programs. The objectives of ESSE 21 are to support and expand a diverse and active community of Earth system science faculty and scientists; to foster and enrich the grassroots development of high-quality, interdisciplinary Earth system science content using NASA data, research and resources; and to provide an infrastructure that supports the sharing, extension and leveraging of resources.

CONTACTS: Donald Johnson, **Phone:** 608-262-2538, **Email:** donj@ssec.wisc.edu; Martin Ruzek, **Phone:** 920-732-3316, **Email:** ruzek@usra.edu; Universities Space Research Association, 7501 Forbes Blvd., Suite 206, Seabrook, MD 20706, **Email:** es21@usra.edu.

Federation of Earth Science Information Partners

<http://www.esipfed.org>

The Federation of Earth Science Information Partners (ESIP) brings together government agencies, universities, nonprofit organizations and businesses in an effort to make Earth science information available to a broader community. NASA is a sponsoring agency of the ESIP Federation.

The Federation's objective is to evolve methods that make Earth science data (satellite and ground-based) easy to preserve, locate, access and use for all beneficial applications, including research, education, commercial development, agriculture, land management, environmental monitoring, policy making and many other applications.

Visit the Federation Web site to learn about ESIP education services and products for elementary through college levels, informal education and professional development.

CONTACT: Dave Jones, President of the ESIP Federation, Columbia Corporate Park 100, 6021 University Blvd., Suite 140, Ellicott City, MD 21043, **Phone:** 410-203-1316, **Fax:** 410-203-9341, **Email:** dave@stormcenter.com.

Geospatial Workforce Development Center (GeoWDC)

<http://www.geowdc.com>

The GeoWDC at the University of Southern Mississippi is part of the National Workforce Development and Training Initiative (NWDETI) sponsored by NASA. The center is a customer-focused effort designed to meet workforce demands for the emerging geospatial industry, and its goal is to develop a well-trained geospatial workforce that will assist the U.S. in maintaining its leadership in geospatial technologies. The center's efforts are focused on five areas:

- **Leadership**—Activities include the Scholar in Residence program (semester sessions with geospatial practitioners/users) and Webcasts for distance learning.
- **Research**—The *Geospatial Technology Competency Model* can be used to design and develop degree programs and professional development workshops for geospatial professionals.
- **Information**—An online database can be searched by state for remote-sensing classes taught in community colleges.
- **Partnerships**—Including formal partnerships with organizations, as well as information exchange with groups and individuals.
- **Development**—Opportunities for learning and professional development include workshops, training approaches/packages, lesson plans for college educators and industry professionals and an online competency assessment tool.

CONTACT: Email: geowdc@usm.edu.

Goddard Coastal Research Graduate Fellowship Program (GCR)

http://gest.umbc.edu/student_opp/2004_gcr.html

NASA's Goddard Space Flight Center's (GSFC) Earth Sciences Directorate and Wallops Flight Facility, in collaboration with the Goddard Earth Sciences and Technology Center (GEST), led by the University of Maryland, Baltimore County, is offering a limited number of graduate student research opportunities. The program is scheduled for June 7 to August 13, 2004, and is designed to stimulate interest in interdisciplinary Earth science studies by enabling selected students to pursue specially tailored research projects on coastal processes in conjunction with Goddard scientific mentors.

The aim of GCR is to attract and introduce promising students in their first or second year of graduate studies to oceanography and Earth system science career options—through hands-on instrumentation research on coastal processes at NASA's Wallops Flight Facility on the Eastern Shore of Virginia. Each student will be teamed with a mentor with parallel scientific interests to jointly develop and carry out an intensive research project over the 10-week period. Most research will be done at the Wallops Flight Facility; however, there is the possibility that students will have the opportunity to participate in field programs at other locations as well. Mentors can include any Goddard Earth scientist, but most will be drawn from within the Observational Science Branch. Students will be expected to produce final oral and written reports on their summer research activities. The experience will likely help students to enrich their thesis or dissertation topic choices and broaden their scope of research tools.

The program is open to students enrolled in or accepted to accredited U.S. graduate programs in the Earth sciences, physical or biological oceanography, and biological or environmental science disciplines. Students will be selected on the basis of academic record, demonstrated motivation and qualification to pursue multidisciplinary research in the Earth or oceanographic sciences, clarity and relevance of stated research interests to NASA programs, and letters of recommendation. Women, minorities and individuals with disabilities are encouraged to apply. GEST is an Affirmative Action/Equal Opportunity Employer.

Students must commit for the specific full ten-week period. Participants must be either U.S. citizens or foreign nationals in U.S. schools who are either permanent residents or who possess a valid F-1 or J-1 visa. All selected students will be subject to a pre-employment security background check under the current security guidelines. Online applications and instructions can be found on the Web site.

CONTACT: Marci Delaney, Program Coordinator, GEST Center, Code 900.1, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-286-4403, **Email:** mpdelane@umbc.edu.

Graduate Student Researchers Program (GSRP)

<http://fellowships.bq.nasa.gov/gsrp/nav>

GSRP awards fellowships for graduate study leading to masters or doctoral degrees in the fields of science, mathematics and engineering related to NASA research and development.

NASA's GSRP cultivates research ties to the academic community and broadens the base of students pursuing

advanced degrees in science, mathematics and engineering. Earth science research opportunities for graduate students are available at NASA Centers, including: Ames Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Langley Research Center, Marshall Space Flight Center, and Stennis Space Center. Full descriptions of research areas that will be supported are provided on the GSRP Web site. Note that the GSRP also supports the Earth System Science Fellowship Program (see separate entry on p. 4) with NASA Headquarters.

Fellowships are awarded for one year as training grants not to exceed \$24,000 and are renewable for a total of three years based on satisfactory academic advancement, research progress, and available funding. All applicants must be U.S. citizens currently enrolled or accepted as full-time graduate students in an accredited U.S. college or university. All applicants must have a faculty adviser from the institution where they plan to receive their graduate degree. An individual accepting this award may not concurrently receive other Federal fellowships or traineeships.

CONTACT: Visit the GSRP Web site for details about research areas that are supported, eligibility, proposal submission and the application process.

Graduate Student Summer Program In Earth System Science (GSSP)

http://gest.umbc.edu/student_opp/2004_gssp.html

The Earth Sciences Directorate at NASA's Goddard Space Flight Center (GSFC), in collaboration with the Goddard Earth Sciences and Technology Center (GEST), headquartered at the University of Maryland, Baltimore County, is offering a limited number of graduate student research opportunities. The program is scheduled for June 7 to August 13, 2004, and is designed to stimulate interest in interdisciplinary Earth science studies by enabling selected students to pursue specially tailored research projects in conjunction with Goddard scientific mentors.

There are 10 positions available at GSFC and two at GSFC's Wallops Space Flight Facility. Each student will be teamed with a mentor with parallel scientific interests to jointly develop and carry out an intensive research project over the 10-week period. Mentors will be drawn from within the four participating Earth science laboratories at Goddard: the Laboratory for Atmospheres, the Goddard Institute for Space Studies (in New York City), the Laboratory for Hydrospheric Processes, and the Laboratory for Terrestrial Physics. Students will be expected to produce final oral and written reports on their summer research

activities. In addition, students are required to participate in an introductory lecture series on NASA research in the Earth sciences.

The program is open to students enrolled in or accepted to accredited U.S. graduate programs in the Earth, physical or biological sciences, mathematics, or engineering disciplines. Students will be selected on the basis of academic record, demonstrated motivation and qualification to pursue multidisciplinary research in the Earth sciences, clarity and relevance of stated research proposal to NASA programs, and letters of recommendation. Preference will be given to students who have completed at least one year of graduate study. Minorities, women and those with disabilities are encouraged to apply. GEST is an Affirmative Action/Equal Opportunity Employer.

Students must commit for the full 10-week period. Participants must be either U.S. citizens or foreign nationals in U.S. schools who are either permanent residents or who possess a valid F-1 or J-1 visa. All selected students will be subject to a pre-employment security background check under current security guidelines. Online applications and instructions can be found on the Web site.

CONTACT: Marci Delaney, Program Coordinator, GEST Center, Code 900.1, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-286-4403, **Email:** mpdelane@umbc.edu.

GSFC/Howard University Fellowship in Atmospheric Science (GoHFAS)

GoHFAS is a partnership between Howard University and the NASA Goddard Space Flight Center's (GSFC) Laboratory for Atmospheres. The overall goal of GoHFAS is to facilitate the transition from undergraduate to graduate school by challenging students to solve open-ended problems and conduct research. This is accomplished through year-long interaction between students and mentors from participating organizations, including an eight-week summer program and travel back to the research site during the students' winter break to continue work on their projects. The ultimate goal is to increase the number of underrepresented minorities in the atmospheric sciences. Participants are juniors at U.S. universities with majors in the physical sciences, with an emphasis in atmospheric science, chemistry, physics, or related engineering disciplines. Students must have a minimum of one year of college-level calculus and physics or chemistry.

CONTACT: Sonya Smith, Howard University, **Phone:** 202-806-4837, **Email:** ssmith@howard.edu.

Howard University Program in Atmospheric Sciences (HUPAS)

HUPAS, a discipline within Howard University's graduate school, is a direct outgrowth of the Center for the Study of Terrestrial and Extraterrestrial Atmospheres (CSTEa), a NASA University Research Center. Howard University is the only Historically Black College and University that offers an advanced degree in the atmospheric sciences. HUPAS is committed to training students in atmospheric and space-based sciences, and actively engages students in CSTEa research. The program offers a wide array of graduate courses leading to a master of science or doctor of philosophy degree. These courses are taught in the physics, chemistry and mechanical engineering departments. Students work with a variety of research mentors from Howard University, NASA and the National Oceanic and Atmospheric Administration (NOAA). Graduate students may qualify for tuition, fees and stipend packages worth up to \$34,000 per year.

CONTACTS: Vernon Morris, Director, Howard University Program in Atmospheric Sciences, 525 College St. NW, Washington, DC 20059, **Phone:** 202-806-9088, **Email:** vmorris@howard.edu; Demetrius Venable, Director, Center for the Study of Terrestrial and Extraterrestrial Atmospheres, Howard University, 2216 6th St. NW, Room 103, Washington, DC 20059, **Phone:** 202-806-5172, **Fax:** 202-806-4430, **Email:** dvenable@howard.edu.

Minorities Striving and Pursuing Higher Degrees of Success (MS PHD'S) in Earth System Science

<http://msphds.marine.usf.edu>

The MS PHD'S initiative was developed by and for underrepresented minorities with the overall purpose of increasing their participation in Earth system science. The program provides professional development experiences to help advance minority students who are committed to achieving outstanding Earth system science careers. The MS PHD'S initiative sponsors programs that provide participants with:

- Increased exposure to the Earth system science community, via participation in scientific conferences, mentoring relationships and virtual community activities;
- Improved professional skills (e.g., grantsmanship, research, communication, teaching, etc.) and development opportunities;
- Information regarding future funding, education and career opportunities and resources;
- Networking opportunities with established Earth system science researchers and educators; and

- Membership within a virtual community that facilitates networking with and collaboration among peers, junior- and senior-level researchers and educators.

The MS PHD'S in Earth System Science activities are designed to encourage and sustain the interests, as well as facilitate the full participation, of underrepresented minorities in Earth system science-related fields. Student participants are given structured assignments to further prepare them to achieve successful and productive Earth system science careers; create strategic plans to achieve their career goals; develop networks of peers, near-peers and scientists; identify and pursue educational and professional opportunities; and refine their presentations and communication skills.

CONTACT: Ashanti Pyrtle, College of Marine Science, University of South Florida, 140 7th Ave. S., St. Petersburg, FL 33701, **Phone:** 727-553-1301, **Fax:** 727-553-1189, **Email:** apyrtle@marine.usf.edu.

Minority University-Space Interdisciplinary Network (MU-SPIN)

<http://muspin.gsfc.nasa.gov>

NASA created MU-SPIN to help train the next generation of NASA's minority scientists and engineers. The program has remained a highly effective tool throughout its growth and evolution over the past decade. MU-SPIN serves America's Historically Black Colleges and Universities (HBCUs) and Other Minority Universities (OMUs), which include Hispanic Serving Institutes (HSIs) and Tribal Colleges and Universities (TCUs).

The first step for the MU-SPIN program was to provide network infrastructure by helping minority schools to purchase, and even build, computers for the classroom. During its next phase, MU-SPIN established Network Resources and Training Sites (NRTS), allowing the program to expand and target a larger minority community of students, faculty, administrators and community members. Next, MU-SPIN established Expert Institutes to help foster scientific curriculum development and research with the goal of increasing participation in NASA-related science, especially Earth science. MU-SPIN also created the Institutes for Collaborative Research and Education (ICRE) model to further promote NASA science and technology in minority schools.

CONTACT: James Harrington, MU-SPIN Project Manager, Code 933, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-286-4063, **Fax:** 301-286-1775, **Email:** james@muspin.gsfc.nasa.gov.

NASA Academy

<http://www.nasa-academy.nasa.gov>

The success of the U.S. space program is due in large part to cooperation between government, academia and the private sector. Although responsibilities overlap, leaders migrate from one sector to another and details change with administration, the interdependence among these sectors persists. One of the goals of the NASA Academy is to introduce future space leaders to how this system works.

The intent is to give a diverse group of students a working knowledge of NASA and its programs, and to create an environment that fosters creativity, personal initiative, leadership, teamwork, appreciation of diversity, and professional ethics. The Academy accomplishes this by augmenting research with a senior scientist or engineer with interactive sessions with leaders in government, industry and academia, a collaborative group project, lectures, field trips, and oral and written presentations. Students discover how NASA and its field centers operate, understand NASA's link to the private sector, gain experience in world-class laboratories, participate in a team environment and build professional bonds among our future leaders.

Upon successful completion of the Academy, students are inducted into the NASA Academy Alumni Association, which promotes and supports the mission of NASA and the Academy and helps establish a network for communication and support among alumni. Academy graduates often go on to complete advanced degrees and work at NASA Centers, for NASA contractors or in aerospace-related fields ranging from science and engineering to education and journalism.

The NASA Academy was started in 1993 at NASA's Goddard Space Flight Center (GSFC). NASA Academies are currently active at GSFC and NASA's Ames Research Center. Student eligibility requirements include:

- Demonstrated leadership qualities and interest in the space program;
- Enrollment (as of June 1 of the program year) as a junior, senior, or first- or second-year graduate student;
- A minimum B average; and
- U.S. citizenship, U.S. permanent residence (as of June 1 of the program year), or foreign national of a participating space agency.

The NASA Academy is co-sponsored by the National Space Grant College and Fellowship Program, which provides selected students with round-trip transportation to their assigned NASA Center and stipends between \$3,000 and \$4,000. Housing, meals and transportation are provided by the participating NASA Center. The University of Maryland's College of Computer, Mathematical and Physical

Sciences is also a GSFC Academy co-sponsor, granting three credits to participants that successfully complete the program.

The deadline for submitting applications is January 31 of the program year, with the 10-week program held in the June–August time frame. Women, minorities and individuals with disabilities are encouraged to apply. See the Academy Web site for more details and online application.

CONTACT: David Rosage, University Programs Office, Code 603.1, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-286-0904, **Email:** david.rosage@gsfc.nasa.gov. Applicants are also encouraged to contact their local state Space Grant Consortia Office, which can be found at: <http://calospace.ucsd.edu/spacegrant/contacts/allcontacts/allcontacts.html>.

NASA EOS Higher Education Alliance

<http://reason.laits.gmu.edu>

This project mobilizes NASA Earth Observing System (EOS) data and information through Web service and knowledge management technologies for higher education teaching and research. The technologies will be implemented in a standards-compliant, open, distributed, three-tier Web information system called GeoBrain, which will make petabytes of NASA EOS data and information accessible to higher education users, both professors and students. The system will allow users to dynamically and collaboratively develop interoperable, Web-executable geospatial service modules and models, and run them online against any part of the petabytes of archived data to get back customized information products rather than raw data.

This project will bring an unprecedented geospatial learning and research environment to the desktops of students and professors. To realize this goal, researchers and educators from higher education institutions throughout the United States will form the NASA EOS Higher Education Alliance (NEHEA). The NEHEA development team will develop the system, while representatives of the user communities will incorporate the data-enhanced environment into their existing courses and ongoing research, develop new courses that take advantages of the environment, provide feedback to the development team, and promote use of the system, products and tools developed. It's expected that more than 100 universities worldwide will use GeoBrain in teaching and research activities, with more than 1,000 copies of the client installed.

Professors and researchers at higher education institutions are welcome to join NEHEA as representatives of the user communities. Their involvement may be funded

through the Request for Participation (RFP) process managed by NASA's Earth Science Enterprise. Selected representatives will be funded for two years. An RFP is expected to be issued in March, and the selection will be made in June of each year for the first three years of the project.

CONTACT: Liping Di, Laboratory for Advanced Information Technology and Standards (LAITS), George Mason University, 9801 Greenbelt Rd., Suite 316-317, Lanham, MD 20706, **Phone:** 301-552-9496, **Fax:** 301-552-9671, **Email:** lpd@rattler.gsfc.nasa.gov or: ldi@mason.gmu.edu.

NASA Faculty Fellowship Program

<http://www.asee.org/nffp>

The NASA Faculty Fellowship Program (NFFP) offers hands-on exposure to NASA's research challenges through 10-week summer research residencies at participating NASA Centers for full-time science and engineering faculty at U.S. colleges and universities, including two-year institutions. Participants work closely with NASA colleagues on research that is important to NASA's five strategic enterprises.

Fellowships are awarded to qualified faculty members from engineering, science and other related disciplines for work on collaborative research projects of mutual interest to the fellow and the NASA Center. Each fellow will work with a NASA colleague and will be associated directly with the aeronautics and space program and the concomitant basic research problems. Fellows may reapply for a second summer.

The application deadline for the 2004 program was February 2. Approximately 150 fellowships are awarded each year. Stipends are \$1,200 per week, and a travel allowance will also be paid. In addition, an allowance will be provided for those fellows who must relocate. Applicants should be aware that no leave will be granted during the 10-week period, and that fellows are required to conduct their research on-site. Faculty participants will be required to submit a research report and provide program evaluation data at the end of the program. NFFP is jointly managed by the American Society for Engineering Education (ASEE) and the Universities Space Research Association (USRA). The NFFP combines aspects of two successful former and long-running NASA programs, the NASA/ASEE Summer Faculty Fellowship Program and the NASA/USRA Joint Venture (JOVE) program.

CONTACT: Scott Potter, ASEE/NFFP, 1818 N St. NW, Suite 600, Washington, DC 20036, **Phone:** 202-331-3553, **Email:** s.potter@asee.org.

NASA GISS Institute on Climate and Planets (ICP)

<http://icp.giss.nasa.gov>

ICP is a research, science education and minority outreach program at NASA's Goddard Institute for Space Studies (GISS). ICP engages students in grades 9–16 and teachers of grades 7–12 in Earth science research alongside world-class scientists. ICP is the GISS response to a national, state and local movement for scientific institutions to share in the responsibility of providing young people with the highest quality science, mathematics, and technical education. Its overall goal is to increase the pool of interested and academically qualified underrepresented minorities in the pipeline who are successfully completing high school science programs and baccalaureate programs in science, engineering and mathematics.

Through direct research experiences focusing on Earth's climate, ICP seeks to help students develop:

- Views of a world connected regionally and globally;
- Problem-solving skills; and
- Knowledge about the Earth system as it relates to science, technology and society.

Students and educators work on-site or remotely with scientists to create new knowledge that may help us better understand and predict Earth's climate. After-school research internships are available at GISS and cooperating universities. During school, ICP faculty members involve students in new or enhanced curriculum to develop climate change science literacy. Full-time summer enrichment programs offer a more intensive research experience. In-service and pre-service teacher workshops are also conducted to share curriculum. Several ICP spin-off programs are also available as a result of faculty-scientist collaborations.

CONTACT: Carolyn Harris, ICP Director, GISS at Columbia University, 2880 Broadway at 112th St., New York, NY 10025, **Phone:** 212-678-5653, **Fax:** 212-678-5552, **Email:** charris@giss.nasa.gov.

NASA Opportunities for Visionary Academics (NOVA)

<http://education.nasa.gov/nova>

NOVA was created to develop and disseminate a national framework for enhancing science, mathematics, engineering and technology (STEM) literacy for teachers in the 21st century. Using NASA's strategic enterprises, facilities and resources, NOVA provides participating university and college faculty with enhanced knowledge and skills to implement change in university courses. This effort is accomplished through the demonstration of an undergraduate STEM course framework, examples of successful course

models and a mentoring support system for faculty wishing to implement new courses or modify existing ones at their universities or colleges.

NOVA invites interdisciplinary STEM and education faculty teams to participate in three-day workshops that are aligned with national education standards. After successful completion of a workshop, teams are eligible to submit proposals for grants of up to \$34,000 for planning and implementing new courses for preparing K–12 teachers. See the Web site for team and application requirements. NOVA is funded by NASA and is implemented in cooperation with a consortium comprised of the University of Alabama, Fayetteville State University and the University of Idaho.

CONTACT: L. Michael Freeman, Aerospace Engineering and Mechanics, University of Alabama, Box 870280, Tuscaloosa, AL 35487-0280, **Phone:** 205-348-7304, **Fax:** 205-348-4171, **Email:** nova@coe.eng.ua.edu or mike.freeman@ua.edu.

NASA Summer School for High Performance Computational Earth and Space Sciences (HPC)

http://gest.umbc.edu/student_opp/2004_hpc.html

The NASA Goddard Space Flight Center's (GSFC) Earth and Space Data Computing Division (ESDCD) and the Goddard Earth Sciences and Technology Center (GEST) are soliciting applications from qualified graduate students to participate in an intensive lecture series in computational Earth and space sciences during a three-week period from July 5–23, 2004. The ESDCD provides comprehensive research and development support in data handling and computing for NASA Earth and space science research programs. Resident facilities include a 416-processor Compaq, a 1360-processor Cray T3E, a 512-processor SGI Origin 3000, numerous middle-sized supercomputing platforms, and several Beowulf-class systems. Beowulf is a class of inexpensive massively parallel systems designed as a cluster of commodity PC's using LINUX, first conceived at GSFC in the 1990s.

Approximately 15 students will be selected to participate in the three-week program. Students will be given hands-on computer training and interact in small groups. Staff and invited computational scientists will present a series of lectures on advanced topics in computational Earth and space sciences, with emphasis on computational fluid dynamics and particle methods. Lectures will be presented on developing software for massively parallel architectures. Students are encouraged to give a presentation of their thesis research interests during the course of the summer school.

The program aims to attract Ph.D. students in the Earth and space science disciplines whose present or future

research requires large-scale numerical modeling on massively parallel architectures. Eligibility is limited to those Earth and space science students who are U.S. citizens and are enrolled in U.S. universities. Online applications and instructions can be found at the Web site.

CONTACT: Marci Delaney, Program Coordinator, GEST Center, Code 900.1, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-286-4403, **Email:** mpdelane@umbc.edu.

National Space Grant College and Fellowship Program (NSGCFP)

<http://www.bq.nasa.gov/spacegrant>

NSGCFP funds support graduate and undergraduate students throughout the continental United States and Puerto Rico. The criteria for recruitment and selection are determined by the Space Grant consortia. However, all must be U.S. citizens and enrolled in a full-time degree program related to aerospace, which includes aeronautics, Earth and space science, space engineering and related fields. Designated Space Grant institutions provide specialized training and education programs to help maintain the nation's capabilities in aerospace science and technology and education and to capitalize on the multiple opportunities afforded by the space environment. Each state consortium is challenged to:

- Establish a national network of universities with interests and capabilities in aeronautics, space and related fields;
- Encourage cooperative programs among universities, aerospace industry, and federal, state and local governments;
- Encourage interdisciplinary training, research and public service programs related to aerospace;
- Recruit and train professionals—especially women, underrepresented populations and persons with disabilities—for careers in aerospace science and technology; and
- Promote a strong science, mathematics and technology education base from elementary through secondary school levels.

CONTACT: See Web site to connect to the NASA Space Grant institution in your state.

New Investigator Program (NIP) in Earth Science

The New Investigator Program (NIP) in Earth Science was established to promote the integration of Earth system science research and education by scientists and engineers at the beginning stages of their professional careers. The program, designed for investigators in Earth system science and applications at academic institutions and nonprofit organizations, emphasizes the early development of these individuals as both researchers and educators. Scientists and engineers are encouraged to develop a broader sense of responsibility for effectively contributing to the improvement of science education and the public science literacy—and are also provided an opportunity to develop partnerships and enhance their skills, knowledge and ability to communicate the results of their work to teachers, students and the public. Particular emphasis is placed on the investigator's ability to promote and increase the use of Earth remote sensing through the proposed research and education projects.

NIP proposals are openly solicited approximately every 18 months; the latest round of proposals were due August 15, 2003. The awards, to be provided in the form of "education grants," range from \$80,000–\$120,000 per year for a period of up to three years, subject to satisfactory progress and availability of funds. Proposals submitted in response to this announcement will be competing for approximately \$2.0 million per year beginning in fiscal year 2004. Solicitations for new NIP proposals will be made available at: http://research.hq.nasa.gov/code_y/code_y.cfm.

CONTACT: Ming-Ying Wei, NASA Headquarters, Washington, DC 20546, **Phone:** 202-358-0771, **Email:** mwei@hq.nasa.gov.

Partnership Awards for the Integration of Research into Undergraduate Education (PAIR)

http://mured.nasaprs.com/awards/part_awards/pair/index.cfm

The purpose of the PAIR program is to integrate cutting-edge NASA-related research into the undergraduate educational experience, to strengthen teaching and research strategies across academic programs and to enhance collaboration among mathematics, science, engineering and technology (STEM) academic departments—thereby strengthening the STEM baccalaureate degree-producing capacity of a number of the nation's Historically Black Colleges and Universities (HBCUs) and Other Minority Universities (OMUs), which include Hispanic Serving Institutions (HSIs)

and Tribal Colleges and Universities (TCUs). The PAIR program provides an opportunity for these institutions to build upon their NASA-sponsored and NASA-related research across academic disciplines by creating innovative approaches to the interdisciplinary study of STEM.

Partners may include NASA Centers and other institutions of higher education and the aerospace community having substantial involvement in NASA's mission to strengthen the MSET academic infrastructure of minority institutions. The awards are managed by NASA's Minority University Research and Education Programs (MUREP). PAIR Awards with an Earth science focus are:

- **Clark Atlanta University**—Integration of Research and Education in the Area of Earth Systems Science; Kofi Bota, **Email:** kbota@cau.edu
- **City University of New York City College**—Integration of Research and Education in Remote Sensing and Environmental/Climate Studies; Reza Khanbilvardi, **Email:** rk@ce-mail.engr.cuny.cuny.edu
- **Hampton University**—The Center for Lidar and Atmospheric Sciences Students (CLASS); Doyle Temple, **Email:** doyle.temple@hamptonu.edu
- **University of Puerto Rico at Mayaguez**—Partnership for Spatial and Computational Research; Luis Olivieri, **Email:** olivieri@ece.uprm.edu
- **California State University at Northridge**—Analyzing Data Sets; Carol Shubin, **Email:** carol.shubin@csun.edu
- **Norfolk State University**—Mission Leveraged Education: NSU-NASA Innovative Undergraduate Model; S. Raj Chaudhury, **Email:** schaudhury@nsu.edu
- **Heritage College**—Incorporation of Satellite Imagery Analysis in Environmental and Computer Science Curricula; Dr. James Falco, **Email:** falco_j@heritage.edu

CONTACT: Mabel Matthews, MUREP, Code N, NASA Headquarters, Washington, DC 20546, **Phone:** 202-358-0406, **Email:** mmatthew@hq.nasa.gov.

Satellite Observations in Science Education

The long-term goal of this project is to improve the teaching and learning of the Earth system through quality educational resources that make use of satellite observations. Strategies include:

- Creating effective tools and strategies for preparing students for careers in remote sensing;
- Promoting and supporting Web-based, remote-sensing learning activities; and
- Training students on the appropriate use of observations to address complex real-world problems.

A Web-based education environment is being developed to provide students at the post secondary level with interactive learning experiences on remote-sensing principles and exploratory data analysis. Real-time and historical data sets will be available for student inquiry, and interactive exercises are being developed that engage students to reflect on how scientists explore new concepts and answer questions. Also under development is a tool that will aid students in learning how to explore databases, so that an understanding of the world is attained through manipulations and discovery, rather than an examination of the world through simple point-and-click activities.

Contact: Steven Ackerman, University of Wisconsin-Madison, Cooperative Institute of Meteorological Satellite Studies, 1225 W. Dayton St., Madison, WI 53706,
Phone: 608-263-3647, **Fax:** 608-262-5974,
Email: stevea@ssec.wisc.edu.

Significant Opportunities in Atmospheric Research and Science (SOARS)

<http://www.ucar.edu/soars>

SOARS is dedicated to increasing the number of historically underrepresented students enrolled in master's and doctoral degree programs in the atmospheric and related sciences—with the goal of increasing ethnic diversity within the scientific community of the future. It provides undergraduate and graduate students with educational and research opportunities, mentoring, career counseling and guidance, and the possibility of financial support for a graduate-level program.

The program offers summer research internships, including a 10-week summer program at the National Center for Atmospheric Research or other national laboratories. The 10-week summer program typically starts in early June and continues through mid-August. Participants receive a stipend, housing and transportation costs.

SOARS was established by the University Corporation for Atmospheric Research through partnership with the National Science Foundation and support from the Department of Energy, National Oceanic and Atmospheric Administration, NASA, and the UCAR university community.

CONTACT: SOARS Program Office, University Corporation for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307, **Phone:** 303-497-8622, **Fax:** 303-497-8629, **Email:** jwhite@ucar.edu.

Summer Institute on Atmospheric, Hydrospheric and Terrestrial Sciences

http://neptune.gsfc.nasa.gov/~fj2pg/sum_inst.html

NASA's Goddard Space Flight Center (GSFC) convenes an annual summer institute for undergraduate students that focuses on atmospheric, hydrospheric and terrestrial sciences. The first part of the program is a one-week series of lectures given primarily by GSFC scientists describing proposed areas of research in these subject areas. Based on these lectures and perceived compatibilities, students select a mentor and a desired area of research. The following nine weeks are devoted to an intensive research project with the mentor. Students are required to present their results orally at a closing symposium and in a written report. The program is directed at undergraduates majoring in one of the physical sciences, and who are in their junior year at the time of application. However, all undergraduates are eligible to apply. No previous experience in atmospheric, hydrospheric or terrestrial sciences is needed.

The deadline for receipt of applications is in February, with awards announced in March. All applications receive consideration, without regard to race, color, age, national or ethnic origin, or sex. Due to increased security restrictions at GSFC, acceptances are limited to U.S. citizens or those who possess a Green Card signifying their intent of becoming citizens. See Web site for application procedures.

CONTACT: Per Gloersen, Code 971, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-5710, **Fax:** 301-614-5644, **Email:** per.gloersen@gsfc.nasa.gov.

Virginia Geospatial Extension Program

<http://www.cnr.vt.edu/gep>

The Virginia Geospatial Extension Program conducts targeted programs that promote the appropriate use of geospatial tools and applications, and integrate geospatial concepts throughout the K–20 educational pipeline. These tools and applications benefit our lives in many ways and

include the global positioning system (GPS), geographic information systems (GIS) and using remote-sensing data sources—satellite imagery and aerial photography—to provide innovative perspectives on local, regional, state and national issues. For example, GIS is to support urban planning, homeland security and to facilitate the management of environmental resources, including forests, wetlands, coastlands and endangered species.

The program is providing K–12 educational outreach in collaboration with the Virginia Space Grant Consortium's OVERspace program, specialized workforce courses and training through Virginia's Community College System and other VSGC member universities, faculty development, and linkages to NASA and other geospatial resources, data and programs. A key component of this program is its participation with Virginia extension agents, through Agriculture and Natural Resource programs and 4-H Youth Educational initiatives, to support the dissemination of information, training and application development at the grassroots level.

The program is sponsored by the VSGC and the Virginia Cooperative Extension, and is co-located at Virginia Tech in the College of Natural Resources and the College of Agriculture/Virginia Cooperative Extension.

CONTACT: John McGee, Geospatial Extension Specialist, 219 Cheatham Hall (0324), Virginia Tech, Blacksburg, VA, 24061, *Phone:* 540-231-2428, *Email:* jmcg@vt.edu.

Visiting Student Enrichment Program (VSEP)

http://gest.umbc.edu/student_opp/2004_vsep.html

VSEP offers students from the high school to graduate level summer internships with the Goddard Earth Sciences and Technology Center (GEST), working with scientists at NASA's Goddard Space Flight Center (GSFC). Students interact with scientists and professionals at a world-class facility, while gaining valuable experience through a project focused primarily on computer science or the application of computers to solve problems in other sciences. VSEP also holds field trips and lectures to broaden appreciation for GSFC's mission and activities. Past student projects have included simulating neural networks, preparing image analysis algorithms on supercomputers, developing computational science applications, and creating interactive Web sites.

GSFC facilities that offer the internships include:

- **The Scientific Computing Facility**, with its advanced computers (i.e., Cray T3E, Cray SV1's, SGI ORIGIN 2K and ORIGIN 3K, SUN E10000 and E6500, IBM RS 6000 SP), the world's largest UniTree mass storage system, as well as a visualization studio.

- **The National Space Science Data Center**, a central repository for the large databases generated from NASA spacecraft.
- **The Data Systems Technology Division**, which provides a full spectrum of hardware and software environments to support applied research and development of advanced solutions to operational problems.
- **Laboratory for Atmospheres**, which researches areas such as atmosphere modeling and climate analysis in support of Earth observing systems; and
- **Laboratory for Hydrospheric Processes**, which researches the oceanic, cryospheric and hydrologic sciences.

The 2004 VSEP runs from June 7 to August 13 at GSFC in Greenbelt, Maryland. (Subject to housing availability, high school students may need to begin or end later, depending on their academic calendar.) VSEP is open to full-time students in computer science, the physical sciences and mathematics. Participants must be either U.S. citizens or foreign nationals in U.S. schools who are either permanent residents or who possess a valid F-1 or J-1 visa. All selected students will be subject to a pre-employment security background check under current security guidelines. Online applications and instructions can be found at the Web site.

CONTACT: Visiting Student Enrichment Program, Code 900.1, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Email:** vsep@gsfc.nasa.gov.



Informal Education

NASA's ESE seeks to increase public scientific literacy of Earth system science and climate change by engaging the public in shaping and sharing the experience of exploration and discovery. NASA is doing this by:

- Providing engaging Earth system science content and human resource support to informal learning institutions for the benefit of all learners; and
- Cultivating citizens' abilities to get the data, resources and information they need to satisfy their own curiosity about how the Earth system works and/or take actions to meet individual or societal needs.

Informal learning opportunities arise in many venues, including museums, science and nature centers, public lands management groups and agencies, community and youth groups, and the mass media. NASA Earth system science informal education efforts are building and maintaining relationships with informal educators, with a focus on providing content and expertise for these professionals. The program also develops and distributes a rich variety of Earth system science education resources and materials that can be used by informal educators and audiences—these are listed in the “Products & Resources” section of the current catalog. This section describes informal education projects and activities that are supported by NASA's ESE.

The Dynamic Earth

<http://www.discoverycube.org>

Located in Santa Ana, California, Discovery Science Center is a nonprofit organization dedicated to educating young minds, assisting teachers and increasing public understanding of science, math and technology through interactive exhibits and programs. The center's Dynamic Earth program includes:

- A curriculum packet containing lesson plans on several topics, such as earthquakes, atmospheric sciences and water quality monitoring;

- A program for training teachers in the use of the lesson plans—the six-hour training covers 2–3 weeks of classroom instruction; and
- An interactive science presentation featuring hands-on exhibits, including an earthquake simulation room, an eight-foot freestanding tornado, and a kalliroscope that models the fluid dynamics of the ocean and atmosphere.

Participants in Dynamic Earth investigate various topics, including plate tectonics and the changing patterns of land, sea and mountains on the Earth's surface; how the Sun's heating of the Earth's surface drives atmospheric and oceanic circulations, global weather patterns and geographical distribution of marine and terrestrial organisms; and how human impacts on the Earth's atmosphere and waterways affect all life on Earth.

CONTACT: Janet Yamaguchi, Vice President, Education, Discovery Science Center, 2500 North Main St., Santa Ana, CA 92705, **Phone:** 714-542-2823, **Fax:** 714-542-2828, **Email:** jyamaguchi@discoverycube.org

Earth as Art

<http://landsat.gsfc.nasa.gov/earthbasart>

<http://landsat7.usgs.gov/gallery/index.php>

Landsat satellites have been acquiring stunning images of the Earth's land surface and coastal regions since 1972. The program is jointly managed by NASA and the U.S. Geological Survey (USGS), and has provided a wealth of data and information for research and education on land use and land cover change over time.

The Library of Congress celebrated the 30th anniversary of the launch of the first Landsat satellite with an exhibit that showcased imagery from Landsat 7, the latest in the Landsat series. Images were selected purely on aesthetic, rather than scientific, value. You can view the images that were included in this exhibition at: <http://www.loc.gov/exhibits/earthbasart/ea-exhibit.html>.

Earth as Art is an online gallery that features images from the original exhibit, as well as more recent imagery from NASA's Landsat and Terra satellites. High-resolution versions of the images may be downloaded for free (please credit

images to "USGS/NASA"). Poster-size prints of selected images may be ordered at cost from the USGS at: <http://landsat7.usgs.gov/gallery>; click on "Earth as Art" at right, then click on any image. NASA's Goddard Space Flight Center also has a limited number of mounted and framed posters that can be borrowed and displayed in the context of an Earth system science education program.

CONTACT: Jeannie Allen, Code 923, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6627, **Email:** jeannie.allen@gsfc.nasa.gov.

Earth Observatory

<http://earthobservatory.nasa.gov>

NASA's Earth Observatory is an interactive Web-based magazine where the science-attentive public can obtain new satellite imagery and scientific information about our home planet. The focus is on Earth's climate and environmental change. The site is also designed to be useful to public media and educators. Any and all materials published on the Earth Observatory are freely available for re-publication, re-use or re-broadcast (except in rare cases where copyright is indicated).

Visit the Earth Observatory to read feature articles on wide-ranging Earth system science topics, download datasets and images for analysis, read breaking news, learn about current and planned Earth missions, search an online library for reference materials, track natural hazards around the world in near real time, and access interactive experiments and classroom activities.

CONTACT: David Herring, Code 913, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6219, **Email:** dherring@climate.gsfc.nasa.gov.

Earth Science Enterprise Museum Support

The goal of this program is to understand how NASA's Earth science education program can best support the needs of informal educators, especially at museums, science centers, aquaria and zoos. The project started in 1999 when NASA's Jet Propulsion Laboratory (JPL) worked with the Denver Museum of Natural History and 11 other museums to develop and conduct a survey of informal education priorities in Earth science and interest in future programs. In 2000, development began on programs identified in the survey, including Earth science workshops and informal education partnerships.

The project continues to develop relationships with a broad spectrum of informal science education organizations across the country.

Activities include providing professional development on NASA Earth science content and resources to staff of science centers and museums, in partnership with professional organizations. In 2003, JPL piloted this program with the Association of Science-Technology Centers (ASTC) by presenting an ASTC RAP (Roundtable for the Advancement of the Professions) entitled "Making NASA's Earth Science Resources Work for You." The goal of the program is to create a community of museum professionals who are knowledgeable about NASA resources; the objective of the RAP was to bring current research and information resources to the participants.

CONTACT: Anita Sohus, 4800 Oak Grove Dr., Pasadena, CA 91109; **Phone:** 818-354-6613; **Fax:** 818-354-7586; **Email:** anita.w.sohus@jpl.nasa.gov.

E-Theater

<http://etheater.gsfc.nasa.gov>

Large-screen format digital theater presentations displaying new NASA Earth science data sets in high definition are available to technical and non-technical audiences.

Presentations demonstrate new science results using the latest information technology tools in an interactive digital presentation. An increasing number of presentations are offered annually around the country and the world to audiences of the international science and technology community. At least three months' notice is preferred for scheduling.

CONTACT: Fritz Hasler, Code 912, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6270, **Email:** hasler@agnes.gsfc.nasa.gov.

Eyes on Earth

<http://www.oms.edu/visit/earth/eyesonearth>

Eyes on Earth is a new, interactive science exhibition developed by the Oregon Museum of Science and Industry (OMSI) that focuses on NASA's Earth Observing System (EOS) and examines how satellite observations are made and what we can learn about the Earth using space technology. Designed primarily for families and school groups (upper elementary through adults), visitors learn what a satellite is, discover the different types of orbits and explore cutting-edge technology similar to that used by EOS scientists. Eyes on Earth brings these concepts "down to Earth" through a combination of fun, accessible interactives in a playful and "spacey" environment. The exhibit explores three major areas: Satellites, Orbits and Satellite Technology.

The exhibit is available for rental beginning Summer 2004. Contact the OMSI Traveling Exhibits program for pricing and availability.

CONTACT: OMSI Traveling Exhibits, 1945 SE Water Ave., Portland, OR 97214, **Phone:** 503-797-4659, **Email:** travelingexhibits@omsi.edu.

Federation of Earth Science Information Partners

<http://www.esipfed.org>

The Federation of Earth Science Information Partners (ESIP) brings together government agencies, universities, nonprofit organizations and businesses in an effort to make Earth science information available to a broader community. NASA is a sponsoring agency of the ESIP Federation.

The objective of the Federation is to evolve methods that make Earth science data (satellite and ground-based) easy to preserve, locate, access and use for all beneficial applications, including research, education, commercial development, agriculture, land management, environmental monitoring, policy making and many other applications.

Visit the Federation Web site to learn about ESIP education services and products for elementary through college levels, informal education and professional development.

CONTACT: Dave Jones, President of the ESIP Federation, Columbia Corporate Park 100, 6021 University Blvd., Suite 140, Ellicott City, MD 21043, **Phone:** 410-203-1316, **Fax:** 410-203-9341, **Email:** dave@stormcenter.com.

Forces of Change

<http://www.mnh.si.edu/exhibits/forces>

Forces of Change is a comprehensive program at the Smithsonian's National Museum of Natural History about the dynamics of global change. Funded by NASA and other donors, it explores the geological, environmental and historical processes that shape our world. In addition to producing exhibits for display at the museum, the Forces of Change team is developing traveling exhibits, classroom activities, publications, interactive computer programs, a Web site and other outreach materials.

The Forces of Change exhibition hall features case studies on the forces that have shaped and sustained Earth since the beginning of geologic time. Forces of Change exhibits combine traditional and high-tech approaches to learning about Earth systems and managing our precious natural resources. Currently on display in the Forces of Change Hall is the Global Links exhibit (see listing on the next page).

CONTACT: Barbara Stauffer, National Museum of Natural History, Office of Exhibits, 10th and Constitution, Washington, DC 20560-0101, **Phone:** 202-357-2377, **Fax:** 202-786-2567, **Email:** stauffer.barbara@nmnh.si.edu.

Global Climate Change and You: Workshops for Girl Scout Leaders

<http://www.girlscouts.org>

Girl Scouts of the USA has teamed up with NASA in an effort to support new and existing local Girl Scout council and national science initiatives. "Global Climate Change and You" is a workshop series for Girl Scout leaders. Through field work and hands-on activities, leaders develop the skills and experience needed to confidently engage their troops in Earth system science.

This collaboration is designed to:

- Enhance Girl Scout programs geared toward increasing understanding of, and interest in, science among girls and adults;
- Build on existing Girl Scout science, math and technology curriculum through in-depth exploration of science topics; and
- Provide opportunities for girls to discover diverse career options.

Resources available to the councils include interactive science activities for science events, online access to science activities through the "Just 4 Girls" pages (<http://j4g.girlscouts.org>), Scout Interest Project Awards, event speakers (including women scientists), training workshops on Earth science topics, and participation in special events sponsored by NASA.

NASA's Langley Research Center designs and sponsors workshops especially for Girl Scout trainers. These workshops develop skills in Earth system science, climate change and atmospheric science. Workshop participants are able to return to their councils ready to train leaders to work with girls in the areas of Earth system science and global climate change. Workshops available by application; interested trainers can check with their local Girl Scout council for the latest information on upcoming workshops.

CONTACT: Arlene Levine, NASA Langley Research Center, Hampton, VA 23681-0001, **Phone:** 757-864-3318, **Email:** a.s.levine@larc.nasa.gov.

Global Links

http://www.mnh.si.edu/exhibits/global_links

NASA and the Smithsonian's National Museum of Natural History have collaborated to design an Earth system science exhibit called Global Links, as part of the museum's Forces of Change program (see listing on the previous page). The exhibit advances the public's understanding of Earth system science by combining NASA's expertise in space-based observations with the museum's renowned collections and experience in object-based science education. By relating museum specimens with remote-sensing visualizations, the exhibit capitalizes on the unique capability of space-based imagery to present a global perspective of the Earth, and the unique appeal of seeing and interacting with tangible evidence of the Earth's dynamics and history.

CONTACT: Barbara Stauffer, National Museum of Natural History, Office of Exhibits, 10th and Constitution, Washington, DC 20560-0101, **Phone:** 202-357-2377, **Fax:** 202-786-2567, **Email:** stauffer.barbara@nmnh.si.edu.

Immersive Earth: Teaching Earth Science by Fulldome Experiences and Hands-On Exhibits

<http://earth.rice.edu>

Immersive Earth uses the unique capabilities of widescreen theaters to teach Earth science concepts. This project is an outgrowth of Museums Teaching Planet Earth, the first and only group to create Earth science content for the fulldome theater. Projection systems will be placed in cooperating museums to bring Earth science shows to rural regions and underserved communities. A desktop viewer will also be created so that individuals can view the shows on their personal computers. Anticipated shows are "Earth's Wild Ride," "Earth in Peril" and "Earth in the Balance."

An additional component of the program, the Global Links Portal Project, will adapt Earth system science exhibit units developed for the National Museum of Natural History and make them available to educators for classroom use. The units are designed to include several interactive computer components, allowing visitors to explore complex and dynamic material, including satellite imagery and visualizations. The exhibit content will be adapted and made available, along with the interactive components, on the Internet. Also, teacher guides and supplemental activities to go with the exhibits will be developed for classroom use. Units will include updatable NASA material and will be aligned with national education standards for science, math, geography and social studies.

CONTACTS: Patricia Reiff, Rice University, **Phone:** 713-348-4634, **Fax:** 713-348-5143, **Email:** reiff@rice.edu; Carolyn Sumners, Houston Museum of Natural Science, **Phone:** 713-639-4632, **Fax:** 713-639-4635, **Email:** csumners@hmns.org.

Museums Teaching Planet Earth

<http://mtpe.com/mtpe/mtpe.html>

Museums Teaching Planet Earth (MuTPE) is an innovative program sponsored by the Federation of Earth Science Information Partnership (ESIP), a program of NASA's Earth Science Enterprise. MuTPE uses three independent mechanisms for educating the public about Earth science:

- **Earth Update**—An interactive educational computer program, Earth Update works as a stand-alone exhibit at a museum or school, or as a CD-ROM resource for personal use. Real-time data is displayed for five of the Earth's spheres—the atmosphere, biosphere, cryosphere, geosphere and hydrosphere.
- **The Globe Theater**—Using multiple, overlapping, computer-driven projectors, Rice Space Institute has created an "immersive" dome-shaped theater capable of showing Earth science-related productions using "SkyVision" projection technology from Sky-Skan of Nashua, New Hampshire.
- **Earth Forum**—This is a successful operational simulator and exhibit at the Houston Museum of Natural Science. In simulator mode, the Earth Forum is designed for 24–36 students working for 1.5–2.5 hours. Student teams are assigned to workstations representing the world's continents and resources. Using MuTPE databases, they evaluate the effects of an increasing global population on their continent and resources. Students play the roles of geographers, demographers, statisticians, and resource and political scientists.

CONTACT: Patricia Reiff, Rice University, **Phone:** 713-348-4634, **Fax:** 713-348-5143, **Email:** reiff@rice.edu.

Virginia Geospatial Extension Program

<http://www.cnr.vt.edu/gep>

The Virginia Geospatial Extension Program conducts targeted programs that promote the appropriate use of geospatial tools and applications, and integrate geospatial concepts throughout the K–20 educational pipeline. These tools and applications benefit our lives in many ways and include the global positioning system (GPS), geographic information systems (GIS) and using remote-sensing data

sources—satellite imagery and aerial photography—to provide innovative perspectives on local, regional, state and national issues. For example, GIS is to support urban planning, homeland security and to facilitate the management of environmental resources, including forests, wetlands, coastlands and endangered species.

The program is providing K–12 educational outreach in collaboration with the Virginia Space Grant Consortium's OVERspace program, specialized workforce courses and training through Virginia's Community College System and other VSGC member universities, faculty development, and linkages to NASA and other geospatial resources, data and programs. A key component of this program is its participation with Virginia extension agents, through Agriculture and Natural Resource programs and 4-H Youth Educational initiatives, to support the dissemination of information, training and application development at the grassroots level.

The program is sponsored by the VSGC and the Virginia Cooperative Extension, and is co-located at Virginia Tech in the College of Natural Resources and the College of Agriculture/Virginia Cooperative Extension.

CONTACT: John McGee, Geospatial Extension Specialist, 219 Cheatham Hall (0324), Virginia Tech, Blacksburg, VA, 24061, *Phone:* 540-231-2428, *Email:* jmcg@vt.edu.

Where on Earth...? MISR Mystery Image Quizzes

<http://www-misr.jpl.nasa.gov/education/whereonearth.html>

Embark on a geographical adventure with NASA's Multi-angle Imaging SpectroRadiometer (MISR) Mystery Image Quizzes. These puzzles cover topics from archaeology to zoology and are designed to inspire understanding of the physical, biological and human processes that influence our home planet. Several resources for discovering and revealing the meaning of image features may help new geographical detectives to solve the challenging quiz questions.

A new mystery image and quiz appear approximately once every two months at the Web site listed above and at the MISR home page (<http://www-misr.jpl.nasa.gov>). Answers are published at the same locations. The names and hometowns of respondents who answer all questions correctly by the deadline will also be published in the order responses were received. The first three people on this list who are not affiliated with NASA, JPL or MISR, and who have not previously won a prize, will be sent a print of the image.

CONTACT: Clare Averill, MISR Team, Geographic Interpretation and Science Outreach, **Email:** caverill@sdsio-mail.jpl.nasa.gov.





Products & Resources

NASA ESE produces and sponsors a wide-ranging suite of Earth system science education products for elementary through post secondary instruction and informal education. ESE education materials are designed to support standards-based education (including science, mathematics, geography and technology standards) and to supplement existing curricula.

The ESE education resources listed here have all passed an independent peer review. The review includes panels of educators and scientists, who assess learning resources based on their scientific accuracy and educational value. The purpose of the reviews is to help ensure that education materials distributed by NASA are of high quality and meet rigorous education standards. For more information about the review, visit: earth.nasa.gov/education/esereview.

Most of these materials are available over the Internet. Many are also available for free at NASA Educator Resource Centers (spacelink.nasa.gov/ercn) or for purchase from NASA's Central Operation of Resources for Educators (core.nasa.gov), which distributes materials to teachers, nationally and internationally, for a shipping and handling charge.

| | |
|---|-----------|
| Elementary & Secondary | 1 |
| Higher Education | 22 |
| Informal Education | 29 |

Elementary & Secondary

Classroom/Curriculum Materials

| | |
|------------------------------|----|
| Elementary | 1 |
| Middle School | 5 |
| Middle-High School | 6 |
| High School | 11 |

Resources

| | |
|--|----|
| Bookmarks | 12 |
| Book Covers | 12 |
| Books | 12 |
| Brochures | 13 |
| Earth Science Data & Imagery | 13 |
| Lithographs | 14 |
| NASA Facts | 14 |
| Posters | 15 |
| Slide Sets (35mm) | 15 |
| Videotapes | 16 |
| Web Sites | 18 |

Classroom/Curriculum Materials

ELEMENTARY

The Adventures of Amelia the Pigeon

<http://imagers.gsfc.nasa.gov/amelia/index.html>

This interactive adventure engages children in a story-based scenario that emphasizes concepts of remote sensing and how NASA scientists use satellite imagery to better understand the Earth's environmental changes. It introduces students to Earth science concepts, beginning with classifying objects in satellite images by shape, color and texture, building a foundation for interpreting and under-

standing remote sensing. The story is set in New York City, chosen for its size, diversity and the visibility of prominent features in satellite imagery. Lesson plans to accompany the adventure are in development.

Recommended for: children ages 5–10.

The Adventures of Echo the Bat

<http://imagers.gsfc.nasa.gov/k-4/index.html>

<http://catalog.core.nasa.gov/core.nsf/item/300.1-06P>

This picture book of Echo the Bat is accompanied by a set of activities that reinforce four basic themes or concepts fundamental to the interpretation of satellite imagery: perspective, shape and pattern, color, and texture. Activities and activity sheets are also provided on a companion Web site: <http://imagers.gsfc.nasa.gov/k-4>.

Recommended for: children ages 5–10.

The Air We Breathe

Available spring 2004 from NASA CORE at:

<http://core.nasa.gov>

Children entering the classroom have different levels of experiences. The picture book *The Air We Breathe* is designed to provide a common level of knowledge about Earth's atmosphere among students, and a foundation from which the teacher may launch a study of the atmosphere's composition and its importance to life.

Recommended for: K–4.

Climate Change Presentation Kit, 1999

<http://www.epa.gov/enviroed/globalclimate.html>

The Climate Change Presentation Kit is offered as a resource to help prepare talks for students or the general public. The toolkit allows teachers the option of picking and choosing the components that they would need to communicate climate change issues to audiences. It contains fact sheets, a PowerPoint slide presentation and interactive activities that are designed to interest audiences of all levels. Order this free CD-ROM at the Web site provided.

Recommended for: elementary–college educators, informal educators.

Earth Systems Connections

<http://www.ias.sdsmt.edu/esc>

Earth Systems Connections (ESC) is an elementary science, mathematics and technology curriculum that consists of multifaceted lessons organized into seven learning modules. Over 100 activities are contained within the ESC lessons. Each activity has been designed to develop in students a rich sense of how the Earth operates as one interconnected system. Visit the ESC Web site to access sample lessons from the curriculum. **Recommended for: K–5.**

Earth Update

<http://earthb.rice.edu/connected/earthupdate.html>

<http://core.nasa.gov>

Rice Space Institute developed this CD-ROM, which contains Earth science information, movies and classroom activities. The CD is suitable as a stand-alone museum kiosk or for use in a school classroom or library. Today's data can be downloaded from the Internet with a single click. Each "sphere" (atmosphere, biosphere, cryosphere, geosphere and hydrosphere) can be run separately or as the linked *Earth Update*. Each sphere includes the sections: What (What is the atmosphere), Who (Who studies the biosphere), Why (Why do we study the cryosphere?) and How (How do we study the geosphere?). The CD includes classroom activities aligned with national science, math and geography standards.

Recommended for: K–12 and informal education.

Everyday Classroom Tools

<http://bea-www.harvard.edu/ECT>

The major theme explored in this curriculum is the pattern of change on planet Earth as it relates to the Sun. So many different subjects can be usefully mapped to this set of investigations of the world around us that it gives educators an opportunity to build upon an inquiry framework with their own related and connected ideas from different disciplines.

Recommended for: grades K–6.

Exploring Earth from Space: Lithograph Set and Instructional Materials, LS-2002-12-HQ

<http://spacelink.nasa.gov/products/ExploringEarth>.

From Space

<http://catalog.core.nasa.gov/core.nsf/item/300.1-36P>

Space Shuttle astronauts and the EarthKAM program provide photos of our planet from the unique perspective of Earth's orbit. This resource can enhance students' studies of Earth and space science, geography, social studies, mathematics, and educational technologies. The set contains an educators' guide, student information and worksheets, and several Earth photos taken from the Space Shuttle.

Recommended for: grades 3–12.

From a Distance: An Introduction to Remote Sensing/GIS/GPS

<http://education.ssc.nasa.gov/ltp>

This Web site includes lesson plans on remote sensing for grades K–3, 4–8 and 9–12, and links to related education resources. **Recommended for: K–12.**

Glacier Power

<http://www.asf.alaska.edu:2222>

<http://catalog.core.nasa.gov/core.nsf/item/400.0-89>

Published in 1997, *Glacier Power* was developed in cooperation with NASA by the Alaska Synthetic Aperture Radar Facility (ASF) at the University of Alaska, Fairbanks and in cooperation with the Fairbanks North Star Borough School District and the University of Alaska Fairbanks, School of Education. The guide includes information on glaciers and their importance to climate studies; lesson plans; student review exercises, activities and projects; and resources such as glacier imagery, satellite imagery, illustrations, diagrams and more. Available online at the Web site provided or on CD-ROM from NASA CORE.

Recommended for: grades 3–5.

GLOBE Program Learning Resources

<http://www.globe.gov>

K–12 students from all over the world are participating in the GLOBE program by taking environmental measurements at their schools and sharing their data via the Internet. NASA scientists use GLOBE data in their research and provide feedback to the students. GLOBE student observations and measurements cover the following areas: atmosphere/climate, hydrology, land cover/biology, soils and phenology.

GLOBE learning resources are distributed through teacher training workshops. They can also be freely downloaded from the GLOBE Web site or ordered from NASA CORE (<http://core.nasa.gov>):

- **GLOBE Earth System Science Poster and Activity Guide**—The poster represents visual data collected from satellites, ground based observations, and model predications representing solar energy, average temperature, cloud cover, precipitation, soil moisture and vegetation over a 12 month period in 1987.
- **GLOBE Protocol Videos: Atmosphere, Hydrology, Land and Soil**—These videos were created for teachers trained in GLOBE protocols at a GLOBE Workshop to use as a review, in addition to the *Teachers Guide*, before teaching the protocols.
- **GLOBE Videos: Overview, Water Transparency, and Earth as a System**—CD-ROM with sample videos about the GLOBE Program.
- **GLOBE Teachers' Guide**—This guide includes separate chapters on measurement areas (for example, Soils or Earth as a System), data sheets, and lab and field guides for the different measurements.

Mission Geography

<http://missiongeography.org>

<http://catalog.core.nasa.gov/core.nsf/item/400.1-37>

Mission Geography curriculum support materials link the content, skills and perspectives of *Geography for Life: The National Geography Standards* with NASA missions, research and science. Developed by the Geography Education National Implementation Project (GENIP) at Texas A&M University. **Recommended for: K–12.**

NASAexplores

<http://nasaexplores.com>

NASAexplores provides free weekly K–12 educational articles and lessons on current NASA projects. While many articles focus on aerospace technology and human exploration and development of space, several Earth science articles and lessons appear, such as *Mapping the Earth from Space, I am a Sensor, Volcanoes from the Sky, Relief Maps, Making a Topographic Map, Thickness of the Atmosphere* and many others. **Recommended for: K–12.**

NASA SCI Files™

<http://scifiles.larc.nasa.gov>

The NASA SCI Files™ distance learning series introduces students in grades 3–5 to NASA and integrates mathematics, science and technology through the use of Problem-Based Learning (PBL), scientific inquiry, and the scientific method. The programs can be viewed and videotaped at no cost on PBS-member TV stations and via satellite broadcast. Episodes can also be viewed for free on the Internet via NASA's Learning Technologies channel: <http://quest.arc.nasa.gov/events/sci/index.html> and Knowitall.org at: http://www.knowitall.org/nasa/html_wm/scifiles.html.

You can also contact your local NASA Educator Resource Center (<http://education.nasa.gov/erc>) for a video copy or purchase an episode on videotape from NASA CORE at <http://core.nasa.gov>. The following are recent Earth science-related episodes of the NASA SCI Files™:

- **The Case of the Mysterious Red Light**—Have you ever seen an unusually red sunrise or sunset and wondered why? That's exactly what happens in this episode as the tree house detectives accept the challenge of trying to find the source of the red light (<http://quest.arc.nasa.gov/events/sci/2001/index.html>).
- **The Case of the Shakey Quake**—The tree house detectives are troubled by a strange tremor in the area, and they decide that they need to investigate earthquakes. Join the tree house detectives as they delve into geography, geology and plate tectonics to discover why they're "all shook up" (<http://quest.arc.nasa.gov/events/sci/2002/index.html>).

- **The Case of the Phenomenal Weather**—Join the tree house detectives as they plan a trip to Florida and encounter problems in trying to predict the weather. Learn about violent storms, such as hurricanes and tornadoes, weather fronts, global wind patterns and climates (<http://quest.arc.nasa.gov/events/sci/2001/index.html>).

Our Mission to Planet Earth: A Guide to Teaching Earth System Science, 1994

<http://spacelink.nasa.gov/products/Our.Mission.to.Planet.Earth>

The primary goal of this guide is for children to become familiar with the concept of cycles and to learn that some human activities can cause changes in their environment. **Recommended for: grades K–3.**

The Potential Consequences of Climate Variability and Change

<http://www.strategies.org/CLASS.html#Climate>

The potential impacts of climate variability and change provide the context for these inquiry-based activities. The modules include climate change overview activities for grades 1–4 and 5–12, as well as modules that examine the relationship of climate change to areas such as agriculture, coastal areas, forestry, human health and water. **Recommended for: grades 1–12.**

Space Place

<http://spaceplace.jpl.nasa.gov>

Fun activities for elementary–middle school children to do and make, while they learn about space and Earth science, and the technology that enables science. The “Teachers Corner” on the Web site contains curriculum supplements originally published in the ITEAS’ *Technology Teacher* magazine, including:

- **Keeping Nine Eyes on the Weather**—Build and demonstrate a simple working model of an Earth-orbiting instrument that scientists are using to study the atmosphere and pollutants that could be contributing to global warming.
- **Mapping the Watery Hills and Dales**—Learn how the Global Positioning System (GPS) satellites work. Find out how the TOPEX and Jason-1 satellites use GPS data in making very precise topological maps of the oceans.

Students’ Cloud Observations Online (S’COOL)

<http://scool.larc.nasa.gov>

S’COOL is a real-time, collaborative science experiment that elementary through secondary students conduct with NASA scientists. Participants make ground truth observa-

tions of clouds for comparison with satellite data. These observations help NASA scientists validate the measurements from NASA’s CERES satellite instrument (Clouds and Earth’s Radiant Energy System). The following S’COOL educational resources are available to support the program:

- **Cloud Identification Chart** (http://asd-www.larc.nasa.gov/SCOOL/Cloud_ID.html)—Shows examples of different cloud types and classification, identifies cloud observation basics and information on how clouds were named, and provides an activity on how to make a cloud in a bottle. **Recommended for grades 3–8.**
- **S’COOL Tutorial** (<http://asd-www.larc.nasa.gov/SCOOL/tutorial/scool.html>)—Covers the following: determining satellite overpass time, observing cloud properties, transmitting results to NASA and comparing results with satellite-retrieved properties. **Recommended for grades 3–8.**
- **Student and Teacher Bookmarks** (<http://asd-www.larc.nasa.gov/SCOOL/bookmarks.html>)— Provide basic information about the importance of ground truth measurements for investigative science and the formation of clouds. **Recommended for grades 3–8.**
- **S’COOL Poster and Brochure** (http://asd-www.larc.nasa.gov/SCOOL/post_broch.html)— Provide photos of different cloud types, and information describing the program and how to participate. **Recommended for: grades 3–12.**
- **S’COOL Web Site** (<http://scool.larc.nasa.gov>)— Provides information on the project and how to participate, as well as classroom materials and resources. **Recommended for: grades 3–12.**

Understanding the Biosphere from the Top Down

http://geo.arc.nasa.gov/sge/jskiles/top-down/intro_product/title-page.html

Published in 1996, the 22 lessons in this package focus on studying the biosphere from space to teach students about the Earth system. **Recommended for: grades 4–12.**

Virtual Vacationland

<http://www.bigelow.org/virtual>

The site includes over 40 hands-on activities on the following science topics: land topography, ocean bathymetry, coastal tides, ocean buoy data, ocean temperature, weather and climate, and watersheds and rivers. Each topic has a preview page that summarizes the material. Each topic also has 2 to 5 detail pages, which show where to access online data related to the topic and what the data mean.

Recommended for: elementary–secondary.

Windows to the Universe

<http://www.windows.ucar.edu>

Windows to the Universe brings together scientific content on Earth and space sciences with interdisciplinary content on the arts and humanities. Three levels of content are provided: students (K–12 through undergraduate), teachers and browsing adults. The site includes a rich array of documents, images, movies, animations, sounds, games and data that brings science to life for students, teachers and the interested user. **Recommended for: K–12, informal education.**

MIDDLE SCHOOL**The Adventures of Echo the Bat**

<http://imagers.gsfc.nasa.gov>

This interactive Web site allows students to follow Echo the Bat as he migrates through Arizona. The adventure offers a directed and investigative approach to how land features look from space, what the colors mean in a Landsat image, and an introduction to identifying habitats in a false color Landsat image. The site is supported with a teacher's guide that includes the following units: Understanding Light, Remote Sensing and Biodiversity. **Recommended for: grades 5–8.**

Alaska: A Bird's Eye View

<http://www.uaf.edu/asgp/k12>

In this Web-based, interactive story, Tutangiaq (Too-tang-geye-ack—nicknamed "2T"), a Canada goose, flies across Alaska looking for his family. As he flies, he tells children about the fascinating 49th state. Children learn how Alaska was purchased from the Russians and other facts about the state. They can also compare the size of Alaska to other states. 2T takes a flight across the volcanic chain in Alaska and helps students to interactively explore how scientists monitor volcanoes from satellite images in near-real time. At the coast, the bird also meets his walrus friend who shows him how the sea ice edge has receded and adversely affected marine life. Finally, 2T arrives in Fairbanks where children use satellite imagery to help 2T find and unite with his family. **Recommended for: grades 5–8.**

Event-Based Science (EBS): Remote-Sensing Activities and other Modules

<http://www.mcps.k12.md.us/departments/eventscience/rs.index.html>

These activities enable middle school students to use NASA remote-sensing data as they tackle real-world problems and tasks. The remote-sensing activities enhance the

following EBS modules: *Blight!*, *Earthquake!*, *Fire!*, *Flood!*, *Hurricane!*, *Oil Spill!* and *Volcano!* **Recommended for: grades 5–8.**

NASA CONNECT™

<http://connect.larc.nasa.gov>

NASA CONNECT™ is a series of free, 30-minute, standards-based instructional distance learning programs for students in grades 5–8. Each program is accompanied by an educators' guide describing a hands-on classroom activity, and a Web-based component that reinforces the learning objectives and extends the lesson into a technology-rich environment. The following Earth science-related episodes are available from the NASA CONNECT™ Web site, or can be ordered on videotape from NASA CORE at <http://core.nasa.gov>.

- **Data Analysis and Measurement: Ahead, Above the Clouds**—Students learn about hurricanes and how meteorologists, weather officers, and NASA researchers use measurement and data analysis to predict severe weather such as hurricanes (http://connect.larc.nasa.gov/programs/2000-2001/ahead_clouds.html).

Signals of Spring

<http://www.signalsofspring.net>

Signals of Spring engages students, working in groups, to use Earth satellite imagery to track and explain animal movement. Students conduct investigations of land and marine animals; bald eagles, sea turtles and red-tailed hawks are a few of the animals tracked in real-time. The program is inquiry-based and includes lessons, classroom activities, color and BW transparencies and special interactive, online GIS and 3-D maps and visualizations of animals and their migrations. **Recommended for: grades 6–8.**

SkyMath: Mathematics for a Blue Planet

<http://www.unidata.ucar.edu/staff/blynds/Skymath.html>

The University Corporation for Atmospheric Research (UCAR) developed *SkyMath*, a set of middle school mathematics modules incorporating weather data. *SkyMath* requires teachers and students to acquire and use current environmental and real-time weather data in ways that embrace the dynamic and uncertain natures of these data, in order to promote the teaching and learning of significant mathematics, consistent with the standards set by the National Council of Teachers of Mathematics. The *SkyMath* modules may be freely downloaded from the Internet. **Recommended for: grades 5–8.**

Space Place

<http://spaceplace.jpl.nasa.gov>

Fun activities for elementary–middle school children to do and make, while they learn about space and Earth science, and the technology that enables science. The “Teachers Corner” on the Web site contains curriculum supplements originally published in the ITEAS’ *Technology Teacher* magazine, including:

- **Keeping Nine Eyes on the Weather**—Build and demonstrate a simple working model of an Earth-orbiting instrument that scientists are using to study the atmosphere and pollutants that could be contributing to global warming.
- **Mapping the Watery Hills and Dales**—Learn how the Global Positioning System (GPS) satellites work. Find out how the TOPEX and Jason-1 satellites use GPS data in making very precise topological maps of the oceans.

Visit to an Ocean Planet

<http://topex-www.jpl.nasa.gov/education/cdrom.html>

<http://catalog.core.nasa.gov/core.nsf/item/400.0-92>

This interactive, educational CD-ROM reveals the importance of our oceans to global climate and life. It allows users to explore the Gulf of Mexico with satellite data, investigate the 1997–98 El Niño, discover “what’s up” with Earth-orbiting satellites, and learn about the research activities of real life oceanographers. The curriculum background materials are arranged in the context of widely accepted teaching themes. The CD-ROM also highlights results from NASA’s TOPEX/POSEIDON satellite. Available from NASA CORE on CD-ROM or downloaded as PDF files from the TOPEX Web site provided.

Recommended for: middle school.

MIDDLE-HIGH SCHOOL**Antarctic Expeditions: Ozone**

<http://www.planearthsci.com>

In this adventure, students are “hired” to determine if the size of the Antarctic ozone hole is increasing. They set sail on the Research Vessel Glomar, this time in Antarctica, where they embark on their own investigation following the scientific method by testing a given hypothesis. To assist them, satellite images of ozone concentration and instructional movies are located onboard the ship.

Recommended for: middle–high school.

At Work in the Oceans

<http://catalog.core.nasa.gov/core.nsf/item/400.1-45>

At Work in the Oceans is a CD-ROM that includes material created for the 1999 and 2000 field seasons of the Sustainable Seas Expeditions. The following curriculum units are included: Monitoring a Habitat, Tools for Exploring the Ocean and Oceanography Careers. They feature video clips, Web chat questions and answers, labs, activities and related resources materials. The curriculum units have been mapped to National Science Education Standards, as well as California, Texas and Florida science standards. **Recommended for: middle–high school.**

Atlas of the Ocean: The Deep Frontier Teacher’s Guide

<http://catalog.core.nasa.gov/core.nsf/item/300.1-28P>

This 30-page guide includes classroom activities that feature content taken from National Geographic’s *Atlas of the Ocean: The Deep Frontier*. Subjects include undersea hot spots, underwater archaeology, bioluminescence, coral reefs and polar sea exploration. The book includes maps, charts, deep sea images and black line maps that will allow your students to plot their own findings and notes of discovery. Order from the Web site provided (\$6, plus shipping).

Recommended for middle–high school geography education.

Challenger’s e-Mission: Operation Montserrat

<http://clc.wju.edu/OM>

Produced by the Challenger Learning Center at Wheeling Jesuit University, Operation Montserrat is based on a real, historical event. The volcano on the normally tranquil island of Montserrat has come to life. As flaming pebbles and lava begin their devastation, emergency response teams learn a hurricane is approaching. Using real-time hurricane and seismic data, teams of student specialists assist Mission Control, by videoconference or over the Internet, in saving the residents from certain destruction. The Mission package includes teacher training workshops, lesson plans, assessment materials and online support.

Recommended for: grades 5–10.

Choosing a Career in Atmospheric Sciences

<http://oea.larc.nasa.gov/PAIS/AtmSciCareer.html>

A NASA Fact Sheet describing careers and training in atmospheric science, with links to additional resources.

Recommended for: middle–high school educators.

Climate Change Presentation Kit, 1999

<http://www.epa.gov/enviroed/globalclimate.html>

The *Climate Change Presentation Kit* is offered as a resource to help prepare talks for students or the general public. The toolkit allows teachers the option of picking and choosing the components that they would need to communicate climate change issues to audiences. It contains fact sheets, a PowerPoint slide presentation and interactive activities that are designed to interest audiences of all levels. Order this free CD-ROM at the Web site provided.

Recommended for: elementary–college educators, informal educators.

DataSlate

<http://catalog.core.nasa.gov/core.nsf/item/400.1-53>

DataSlate is a multi-curricular image visualization tool for students. It allows the user to easily and quickly maneuver through huge image data sets; overlay and compare images gathered over time or with different instruments; and observe historical, geographical, geological and environmental change—or to compare images of the same area at different wavelengths. DataSlate includes a CD-ROM (with 12 sample data sets and 12 sample lesson plans), video and teachers' guide. **Recommended for:** middle–high school.

Discover Earth Classroom Materials

<http://www.strategies.org/CLASS.html#Discover>

Discover Earth classroom materials were developed during a series of teacher workshops that were sponsored by NASA. Modules include: *Earth as a System*; *Albedo versus Temperature*; *Ozone*; and *Where Does the Rain Go?* Each module includes the following sections: Key Concepts and Terms, Resources, Background for Teachers, and Classroom Investigations. **Recommended for:** grades 5–12.

Dr. Art's Guide to Planet Earth

<http://www.planetguide.net>

Dr. Art's Guide to Planet Earth explains the Earth system using three concepts: the cycles of matter, the flows of energy and the web of life. The guide then applies these concepts to real-life problems and issues. Developed by WestEd, this Guide is available for purchase on the Web site above. **Recommended for:** middle+.

Earth Expeditions: Global Warming

<http://www.planeteartscience.com>

Students are placed on a research vessel where they run computer climate models to predict how climate in regions around the world may change as the concentration of carbon dioxide in the atmosphere continues to rise. They are charged with determining how climate in four regions of the world (Alaska, northern Canada and Greenland, Europe

and western Russia, western tropical Pacific, and sub-Saharan Africa) may change over the next 100 years as human population continues to increase and non-industrialized nations become industrialized. Their conclusions will help officials advise nations around the world of the potential risks of increased carbon emissions. Students follow the scientific method by testing a given hypothesis on future climate patterns. Computer climate models, a data center and instructional movies are located within the research center to assist them. **Recommended for:** middle–high school.

Earth Update

<http://earth.rice.edu/connected/earthupdate.html>

<http://core.nasa.gov>

Rice Space Institute developed this CD-ROM, which contains Earth science information, movies and classroom activities. The CD is suitable as a stand-alone museum kiosk or for use in a school classroom or library. Today's data can be downloaded from the Internet with a single click. Each "sphere" (atmosphere, biosphere, cryosphere, geosphere and hydrosphere) can be run separately or as the linked *Earth Update*. Each sphere includes the sections: What (What is the atmosphere), Who (Who studies the biosphere), Why (Why do we study the cryosphere?) and How (How do we study the geosphere?). The CD includes classroom activities aligned with national science, math and geography standards.

Recommended for: K–12 and informal education.

Exploring Earth from Space: Lithograph Set and Instructional Materials, LS-2002-12-HQ

<http://spacelink.nasa.gov/products/Exploring.Earth>

From Space

<http://catalog.core.nasa.gov/core.nsf/item/300.1-36P>

Space Shuttle astronauts and the EarthKAM program provide photos of our planet from the unique perspective of Earth's orbit. This resource can enhance students' studies of Earth and space science, geography, social studies, mathematics and educational technologies. The set contains an educators' guide, student information and worksheets, and several Earth photos taken from the Space Shuttle.

Recommended for: grades 3–12.

Exploring the Environment

<http://www.cotf.edu/ete>

This Web site includes online, problem-based modules developed by NASA's Classroom of the Future for K–4, 5–8 and 9–12 teachers and students. The modules address events and issues such as volcanoes, hurricanes, dinosaur extinction theories, deforestation, endangered species and global change. **Recommended for:** grades 5–12.

Exploring Wetlands with Satellite Sensing Exploring Remote Sensing: A Hands-on Experience

<http://baby.indstate.edu/gerstt/bandsn.html>

In *Exploring Wetlands*, principles of remote sensing and examples of environmental applications using remote sensing present the background required for the hands-on CD. *Exploring Remote Sensing* provides digital remote-sensing data of several small study areas from various environments such as wetlands and volcanoes.

Recommended for: grades 7–12.

Finding Impact Craters with Landsat

<http://landsat.gsfc.nasa.gov/education/crater>

Earth and all the other planets and moons of our Solar System have been continuously pelted by asteroids and comets ever since their formation. On Earth, wind and water have eroded away most of the evidence; various other geologic processes have concealed it; oceans and vegetation now cover much of the rest. This activity will help your students understand how NASA scientists are discovering evidence of impact craters through satellite images and technology, which enables us to see landforms that we can't see with our eyes alone. **Recommended for:** grades 5–8.

From a Distance: An Introduction to Remote Sensing/GIS/GPS

<http://education.ssc.nasa.gov/ltp>

This Web site includes lesson plans on remote sensing for grades K–3, 4–8 and 9–12, and links to related education resources. **Recommended for:** K–12.

GLOBE Program Learning Resources

<http://www.globe.gov>

K–12 students from all over the world are participating in the GLOBE program by taking environmental measurements at their schools and sharing their data via the Internet. NASA scientists use GLOBE data in their research and provide feedback to the students. GLOBE student observations and measurements cover the following areas: atmosphere/climate, hydrology, land cover/biology, soils and phenology.

GLOBE learning resources are distributed through teacher training workshops. They can also be freely downloaded from the GLOBE Web site or ordered from NASA CORE (<http://core.nasa.gov>):

- **GLOBE Earth System Science Poster and Activity Guide**—The poster represents visual data collected from satellites, ground based observations, and model predications representing solar energy, average temperature, cloud cover, precipitation, soil moisture and vegetation over a 12 month period in 1987.

- **GLOBE Protocol Videos: Atmosphere, Hydrology, Land and Soil**—These videos were created for teachers trained in GLOBE protocols at a GLOBE Workshop to use as a review, in addition to the *Teachers Guide*, before teaching the protocols.
- **GLOBE Videos: Overview, Water Transparency, and Earth as a System**—CD-ROM with sample videos about the GLOBE Program.
- **GLOBE Teachers' Guide**—This guide includes separate chapters on measurement areas (for example, Soils or Earth as a System), data sheets, and lab and field guides for the different measurements.

How Can We Grow Smarter?

<http://growsmart.gsfc.nasa.gov>

Students use using remote-sensing techniques and data (Landsat, aerial photos and MultiSpec image processing software) to investigate urban sprawl and its consequences in the Washington, D.C. region. The unit design can be customized to suit other problems, besides urban growth, using the same techniques. The lessons can be implemented in a science classroom or in an interdisciplinary manner. **Recommended for:** middle–high school.

Investigating the Climate System: NASA's Tropical Rainfall Measuring Mission (TRMM)

<http://www.strategies.org/TRMM.html>

This series of five problem-based learning modules is designed to bring NASA TRMM science into the middle school classroom. Modules for grades 5–8 include *Clouds, Precipitation, Weather and Winds*; the fifth module, *Energy*, was developed for high school-level audiences. The modules use role-playing scenarios to help students discover real-world applications of data. While these modules were developed under one series title, they were designed so that each module could be used independently.

Recommended for: grades 5–8 and 9–12.

Landsat-7 Datasets: LAN Files for Use with MultiSpec

<http://landsat.gsfc.nasa.gov/education/l7/downloads/index.html>

This site provides a number of Landsat 7 scene subsets as LAN files that are intended for use with Purdue University's MultiSpec software. Users also have the option of downloading the Landsat images as TIFF files in four different band combinations. Links are included to download MultiSpec, a MultiSpec tutorial, and an introduction to remote-sensing PowerPoint presentation with detailed notes.

Recommended for: middle school–undergraduate.

Metropolitan East Coast (MEC) Assessment Educator's Pack

http://metroeast_climate.ciesin.columbia.edu/edumod.html

The MEC Educator's Pack contains geographic information system (GIS) software, data sets and lesson plans designed for educators who are interested in using GIS technology to explore global climate change issues. The package is available on a free, PC-compatible CD (request from the Web site provided), includes a free GIS software program called ArcExplorer by ESRI and comes with a user manual to help get you started. Also provided are two lesson plans that use ArcExplorer to view the data and produce a series of maps to study climate change predictions in the MEC region. **Recommended for: middle–high school.**

Mission Geography

<http://missiongeography.org>

<http://catalog.core.nasa.gov/core.nsf/item/400.1-37>

Mission Geography curriculum support materials link the content, skills and perspectives of *Geography for Life: The National Geography Standards* with NASA missions, research and science. Developed by the Geography Education National Implementation Project (GENIP) at Texas A&M University. **Recommended for: K–12.**

NASAexplores

<http://nasaexplores.com>

NASAexplores provides free weekly K–12 educational articles and lessons on current NASA projects. While many articles focus on aerospace technology and human exploration and development of space, several Earth science articles and lessons appear, such as *Mapping the Earth from Space, I am a Sensor, Volcanoes from the Sky, Relief Maps, Making a Topographic Map, Thickness of the Atmosphere* and many others. **Recommended for: K–12.**

Numbers to Pictures

<http://imagers.gsfc.nasa.gov/teachersite/RGB>

When satellites observe colors from the Earth's surface, the amounts of reflected light are recorded as numbers. This activity illustrates how satellite images are made using flashlights and a color-by-number activity. Students mix the primary colors of light using flashlights (or a Web-based version), investigate the interactions of the light and experiment with trying to create as many colors possible. The activity leads to quantifying the amount of light used to make each color, which students use to "process" a remote-sensed image presented as a color-by-number activity. **Recommended for: middle school.**

OceanWorld

<http://oceanworld.tamu.edu>

Ocean World was developed by Texas A&M University and contains information about many important processes in the ocean. The information about processes is linked to teaching material on other sites and to sources of real-time data that can be used in the classroom. The site also has complete college-level and graduate courses in oceanography and physical oceanography. K–12 material is tied to national and Texas standards for teaching science and mathematics. **Recommended for: middle–high school and undergraduate.**

Pacific Expeditions: El Niño

<http://www.planearthsci.com>

This CD-ROM engages students in a journey where they must navigate their own ship, operate modern research tools, and manipulate satellite and climate model data to investigate and help predict El Niño—one of our planet's largest global climactic disruptions.

Recommended for: middle–high school.

The Potential Consequences of Climate Variability and Change

<http://www.strategies.org/CLASS.html#Climate>

The potential impacts of climate variability and change provide the context for these inquiry-based activities. The modules include climate change overview activities for grades 1–4 and 5–12, as well as modules that examine the relationship of climate change to areas such as agriculture, coastal areas, forestry, human health and water.

Recommended for: grades 1–12.

River Expeditions: The Amazon

<http://www.planearthsci.com>

This CD-ROM brings Earth system science concepts to life by challenging students to conduct modern ecosystem research as it really happens. Students are engaged in a research expedition on the Amazon River flood plain, where they apply modern chemical techniques and evaluate satellite data to discover the role of the floodplain in the trophic ecology of Amazon River fishes.

Recommended for: middle–high school.

Science Seekers: Hidden in Rocks

<http://www.tomsnyder.com>

The American Museum of Natural History developed *Science Seekers*—middle school learning resources that includes CD-ROMs, teacher's guides and hands-on kits. In *Hidden in Rocks*, students play a team of science problem-solvers on special assignment to learn about rock types and

rock formations as they explore how scientists use satellite visualizations to help them identify rocks that might contain fossils. *Hidden in Rocks* consists of three investigations—How does uplift change Earth's surface?; Which rocks contain fossils?; and How does erosion change the landscape?—during which students research information to help them achieve their mission objective. During each investigation, students work in cooperative teams to answer questions that will move them closer to solving the problem. Each step of the way, professional scientists guide students' investigations, describing how they've used technological tools, such as satellite imagery, to solve similar problems—so that students have opportunities to use some of the same technological tools in their mission.

Recommended for: middle school.

Science Seekers: Safe Water

<http://www.tomsnyder.com>

The American Museum of Natural History developed *Science Seekers*—middle school learning resources that includes CD-ROMs, teacher's guides and hands-on kits. In *Safe Water*, students play a team of science problem-solvers on special assignment to investigate how water flows under ground as they use a model to rule out sources of water pollution in a small town. *Safe Water* consists of three investigations—What is groundwater?; How does groundwater get underground?; and Where does groundwater go?—during which students research information to help them achieve their mission objective. During each investigation, students work in cooperative teams to answer questions that will move them closer to solving the problem. Each step of the way, professional scientists guide students' investigations, describing how they've used technological tools, such as computer modeling, to solve similar problems—so that students have opportunities to use some of the same technological tools in their mission. **Recommended for: middle school.**

Students' Cloud Observations Online (S'COOL)

<http://scool.larc.nasa.gov>

S'COOL is a real-time, collaborative science experiment that elementary through secondary students conduct with NASA scientists. Participants make ground truth observations of clouds for comparison with satellite data. These observations help NASA scientists validate the measurements from NASA's CERES satellite instrument (Clouds and Earth's Radiant Energy System). The following S'COOL educational resources are available to support the program:

- **Cloud Identification Chart** (http://asd-www.larc.nasa.gov/SCOOL/Cloud_ID.html)—Shows examples of different cloud types and classification, identifies cloud observation basics and information on how clouds were named, and provides an activity on how to make

a cloud in a bottle. **Recommended for grades 3–8.**

- **S'COOL Tutorial** (<http://asd-www.larc.nasa.gov/SCOOL/tutorial/scool.html>)—Covers the following: determining satellite overpass time, observing cloud properties, transmitting results to NASA, and comparing results with satellite-retrieved properties.

Recommended for grades 3–8.

- **Student and Teacher Bookmarks** (<http://asd-www.larc.nasa.gov/SCOOL/bookmarks.html>)—Provide basic information about the importance of ground truth measurements for investigative science and the formation of clouds. **Recommended for grades 3–8.**

- **S'COOL Poster and Brochure** (http://asd-www.larc.nasa.gov/SCOOL/post_broch.html)—Provide photos of different cloud types, and information describing the program and how to participate. **Recommended for: grades 3–12.**

- **S'COOL Web Site** (<http://scool.larc.nasa.gov>)—Provides information on the project and how to participate, as well as classroom materials and resources.

Recommended for: grades 3–12.

Understanding the Biosphere from the Top Down

http://geo.arc.nasa.gov/sge/jskiles/top-down/intro_product/title-page.html

Published in 1996, the 22 lessons in this package focus on studying the biosphere from space to teach students about the Earth system. **Recommended for: grades 4–12.**

Virtual Vacationland

<http://www.bigelow.org/virtual>

The site includes over 40 hands-on activities on the following science topics: land topography, ocean bathymetry, coastal tides, ocean buoy data, ocean temperature, weather and climate, and watersheds and rivers. Each topic has a preview page that summarizes the material. Each topic also has 2 to 5 detail pages, which show where to access online data related to the topic and what the data mean.

Recommended for: elementary–secondary.

Windows to the Universe

<http://www.windows.ucar.edu>

Windows to the Universe brings together scientific content on Earth and space sciences with interdisciplinary content on the arts and humanities. Three levels of content are provided: students (K–12 through undergraduate), teachers and browsing adults. The site includes a rich array of documents, images, movies, animations, sounds, games and data that brings science to life for students, teachers and the interested user.

Recommended for: K–12, informal education.

World Watcher: Global Warming Project

<http://www.worldwatcher.northwestern.edu/curriculum/MS.btm>

Global warming and its potential impact provide the context for this unit, in which students learn about the scientific factors contributing to the debate. Students act as advisors to the heads of state of several nations and explore the issues as they respond to the various questions and concerns of these leaders. Activities include a combination of physical labs and investigations using World Watcher software, a geographic data visualization tool. Developed by Northwestern University.

Recommended for: middle school+.

HIGH SCHOOL**Arctic Observatory/Sea Ice in the Polar Regions**

<http://catalog.core.nasa.gov/core.nsf/item/400.0-90>

The *Arctic Observatory* includes a teacher's guide and interactively deals with Arctic phenomena and processes, allowing students to ask and answer questions about interrelationships between several physical aspects of the Arctic system. *Sea Ice in the Polar Regions* is a presentation that describes sea ice classification, observation and climate impacts, with voice-over narration. Both resources are available on one CD-ROM from NASA CORE; they can also be downloaded at: <http://www.usra.edu/esse/learnmod.btml>.

Recommended for: high school–adult.

Asian Monsoon

<http://catalog.core.nasa.gov/core.nsf/item/400.1-47>

Students are guided through an investigative journey of the Asian monsoon season, studying weather and climate patterns and their effects on local and world environments. The CD-ROM contains complete teacher, student and resource guides (PDF files) and a Data Visualizer with 4,000 data graphs. A presentation of how the Asian monsoon is studied through data assimilation contains seven QuickTime movies of data and scenes from Asia.

Recommended for: high school.

CEOS Resources in Earth Observation

<http://ceos.cnes.fr:8100/cdrom-98/astart.btm>

The international Committee on Earth Observation Satellites (CEOS) has produced this resource, which contains case studies (examples of Earth observation applications to real-life problems), data and information for education and developing countries. **Recommended for: high school, undergraduate, graduate–professional.**

ChemMatters Special Editions on NASA's EOS Aura

<http://chemistry.org>

Click on the link to “Educators and Students,” scroll down to “High School” and click on the link to “ChemMatters.”

ChemMatters is a quarterly publication of the American Chemical Society, designed and written to demystify everyday chemistry for high school students. The magazine is devoting four special issues annually (beginning in 2001) that will focus on atmospheric chemistry and NASA's Aura mission. Aura will study Earth's ozone, air quality and climate, and conduct research on the composition, chemistry and dynamics of Earth's atmosphere. In addition to science topics, the articles also feature the people behind the mission; each issue also includes a teachers' guide. The special NASA issues and teachers' guides can be freely downloaded as PDF files. **Recommended for: high school.**

Geomorphology from Space, 1986

http://daac.gsfc.nasa.gov/DAAC_DOCS/geomorphology/GEO_HOME_PAGE.btml

<http://catalog.core.nasa.gov/core.nsf/item/400.0-87>

Available on CD and the Web, *Geomorphology from Space* was designed for studying landforms and landscapes. It contains a gallery of 237 color and black and white plates of space imagery, primarily of the Earth, each treating a geographic region where a particular landform theme is exemplified. Each image is paired with a detailed scientific description of the features in the image; some images are accompanied by line drawings, locator maps, geologic maps and on-the-ground photographs of the landform. Available on CD-ROM from NASA CORE at the Web site provided.

Recommended for: high school–adult.

Global Systems Science (GSS)

<http://www.lbs.berkeley.edu/GSS>

The GSS Student Books, developed at the Lawrence Hall of Science, can be combined in various ways to create an interdisciplinary high school course. In the GSS approach, students integrate the traditional disciplines to probe the interactions among the atmosphere, ocean, ice, solid Earth and living organisms that shape Earth's evolution and its future. Students study the traditional disciplines, not as ends in themselves, but as tools for a scientific understanding of Earth as an integrated system. The following GSS books are on topics related to NASA's Earth Science Enterprise: *GSS Teachers' Guide*, *New World View*, *Climate Change*, *Losing Biodiversity* and *Energy Flow*.

Recommended for: grades 9–12.

Into the Arctic: Information and Education Activities for Studying Climate

<http://arcss.colorado.edu/data/arcss069.html>

The University of Colorado/CIRES developed this CD-ROM on climate and climate history in the Arctic, which uses real data and questions from the Greenland Ice Sheet Project Two (GISP2). The lessons and activities are designed for studying Earth science, geography, history, social studies or chemistry. Information and activities are divided into four sections: Climate, Climate Change, El Niño and the GISP 2. **Recommended for: grades 9–12, lower-level undergraduate.**

Journeys through Earth and Space

Guide—<http://ct.gsfc.nasa.gov/journeys>

Video—<http://catalog.core.nasa.gov/core.nsf/item/002.2-33V>

Why are the Rocky Mountains so far inland? How do we preserve the changing Amazon rainforest? When will the Sun fling parts of itself towards Earth? The video magazine *Journeys through Earth and Space* follows three NASA research teams tackling these questions with supercomputers. Researcher interviews mix with scientific imagery and stunning nature footage. An accompanying *Video Resource Guide* provides background material and classroom activities for grades 9–12. Download the Guide from <http://ct.gsfc.nasa.gov/journeys>—or order from NASA CORE, \$3. Order videotape from NASA CORE at the Web site provided, item # 002.2-33V, \$15. Length: 18:00.

Recommended for: grades 9–12.

Studying Earth's Environment from Space

<http://www.ccpo.odu.edu/SEES/index.html>

<http://catalog.core.nasa.gov/core.nsf/item/400.1-46>

This material consists of four modules designed to increase the use of satellite data in science classrooms: *Stratospheric Ozone*, *Global Land Vegetation*, *Oceanography* and *Polar Sea Ice Processes*. Lecture materials are provided, including full-color, printable graphics that are linked to guided-inquiry computer exercises. The software package used for the computer exercises is SEE Image, which is a modified version of NIH-Image. The software runs on Macintosh computers, as well as PCs that are equipped with a Macintosh emulator.

Recommended for: high school–undergraduate.

Understanding the Biosphere from the Top Down

http://geo.arc.nasa.gov/sge/jskiles/top-down/intro_product/title-page.html

Published in 1996, the 22 lessons in this package focus on studying the biosphere from space to teach students about the Earth system. **Recommended for: grades 4–12.**

Resources

The following resources can be useful for developing lesson plans, curriculum supplements, student research projects and sources of NASA Earth science research information and imagery.

BOOKMARKS

Climate Change Bookmarks

This set of bookmarks developed by NASA Langley Research Center includes: *Ozone*, *Biomass Burning*, *Volcanic Aerosols*, *Clouds* and *Human and Natural Impacts on the Earth*. Each bookmark provides a Web address for additional information. Available online at: <http://asd-www.larc.nasa.gov>.

Recommended for: middle school+.

BOOK COVERS

Mathematics of the Great Dismal Swamp—Book Cover

<http://nia.ecsu.edu/nrts/ess/mds/images/bookcover01.jpg>

This book cover was developed by Elizabeth City State University as part of its Mathematic of the Great Dismal Swamp education project.

Recommended for grades 3–8.

BOOKS

Atlas of the Ocean: The Deep Frontier, 2001

<http://sbop.nationalgeographic.com>

Featuring more than 150 photographs, maps and NASA satellite images, this atlas charts and celebrates every aspect of the ocean world, from tiny plankton to massive storm systems that rage across thousands of miles. Experts have contributed essays and sidebars on subjects as diverse as deep-sea archeology, plate tectonics, coral reefs, mapping techniques and El Niño. Readers also go behind the scenes to observe modern science at work, as researchers pursue promising leads in dozens of different but intertwined fields. Order online at the URL provided—or from: National Geographic Society, 1145 17th Street NW, Washington, DC 20036-4688. *Atlas of the Ocean: The Deep Frontier Teacher's Guide* is a 30-page classroom activity guide that features content taken from the atlas. Subjects include undersea hot spots, underwater archae-

ology, bioluminescence, coral reefs and polar sea exploration. Order the teachers' guide from NASA CORE at <http://catalog.core.nasa.gov/core.nsf/item/300.1-28P> (\$6, plus shipping).

The atlas is recommended for: formal and informal education audiences, grade 8–adult; the teachers' guide is recommended for middle–high school geography education.

■ BROCHURES

NASA's Earth Observing System: Terra Spacecraft

http://eospsso.gsfc.nasa.gov/ftp_docs/Terra_brochure.pdf

This brochure gives a brief overview of the Earth science research that is being done with data from the instruments onboard NASA's Terra spacecraft.

■ EARTH SCIENCE DATA & IMAGERY

See also the section on Web sites (p. 18) for a list of individual Earth science missions.

Earth Observatory

<http://earthobservatory.nasa.gov>

NASA's *Earth Observatory* is an interactive Web-based magazine where the science-attentive public can obtain new satellite imagery and scientific information about our home planet. Visit the *Earth Observatory* to read feature articles on wide-ranging Earth system science topics, download datasets and images for analysis, read breaking news, learn about current and planned Earth missions, search an online library for reference materials, track natural hazards around the world in near-real time, and access interactive experiments and classroom activities.

Recommended for: general public, media, informal educators and middle school–post secondary instruction.

Earth Science Picture of the Day (EPOD)

<http://epod.usra.edu>

The EPOD Web site is a collaboration between NASA's Goddard Space Flight Center and the Universities Space Research Association. A new photograph or image highlighting an interesting or unusual aspect of the Earth's system appears every day. Each picture is accompanied by a detailed description and related links. Search the archive by keyword or browse by field or topic.

Recommended for: middle school+, informal education.

Gateway to Astronaut Photography of Earth

<http://eol.jsc.nasa.gov>

This Web site hosts the best and most complete online collection of astronaut photographs of the Earth, including over 480,000 photos from Space Shuttle and the International Space Station. Users can search the database of photos by geographic coordinates or region, mission, features, cloud cover and many other options. The site also features an image of the week, as well as special collections of images, including: Cities, Earth Landscape, Earth-Human Interaction, Distinctive Features, Hurricanes and Weather, Earth's Water Habitat and Geographical Regions.

NASA Distributed Active Archive Centers (DAACs)

<http://nasadaacs.eos.nasa.gov>

The NASA DAACs are the data management and user services branches of NASA's Earth Observing System Data and Information System (EOSDIS). The DAACs process, archive, document and distribute data from NASA's past and current Earth science research satellites and field measurement programs. They were established in the early 1990s, and each DAAC serves a specific science discipline. The DAAC Alliance Annual Feature Articles (<http://nasadaacs.eos.nasa.gov/year-books/index.html>) illustrate how these data sets are being used for wide-ranging science research and applications purposes.

Recommended for: high school educators, undergraduate, graduate–professional.

Landsat-7 Datasets: LAN Files for Use with MultiSpec

<http://landsat.gsfc.nasa.gov/education/l7/downloads/index.html>

This site provides a number of Landsat 7 scene subsets as LAN files that are intended for use with Purdue University's MultiSpec software. Users also have the option of downloading the Landsat images as TIFF files in four different band combinations. Links are included to download MultiSpec, a MultiSpec tutorial, and an introduction to remote-sensing PowerPoint presentation with detailed notes. **Recommended for: middle school–undergraduate.**

United States of America Digital Landsat Mosaics: a 4-CD set of Landsat satellite imagery of the fifty states

<http://catalog.core.nasa.gov/core.nsf/item/400.1-52>

Using the US Digital Landsat Mosaics, we can increase our understanding of Earth system science and the effects humans have on the global environment. The mosaics were developed primarily from data collected by the Landsat 4 and Landsat 5 satellites as they orbited the Earth ten or more years ago. This historical imagery is a

valuable record of the conditions on Earth around the year 1990. The CD was developed by NASA Stennis Space Center and the US Geological Survey. It also includes a basic Landsat tutorial.

Recommended for: high school–adult.

Visible Earth

<http://visibleearth.nasa.gov>

This companion site to the NASA *Earth Observatory* (<http://earthobservatory.nasa.gov>) is a comprehensive image gallery for access to NASA Earth science images, animations and data visualizations. Most resources are available digitally at multiple resolutions, with captions and metadata. **Recommended for:** media and general public.

LITHOGRAPHS

Lithographs contain a color image (e.g., a satellite image), with additional information, classroom activities or discussion questions.

The following lithographs are available to download from NASA Spacelink at: <http://spacelink.nasa.gov/products>.

- 1997-998 El Niño (LG-1998-05-004-GSFC)
- Apollo 17 View of Earth (HqL-363)
- Exploring Earth from Space (LS-2002-12-HQ)
- First Image of the Global Biosphere (HqL-325)
- Understanding Our Changing Planet (HqL-430)
- Water is a Force of Change (HqL-401)
- World Cloud Cover Pattern (HqL-326)

Digital Tectonic Activity Map: Lithograph with Activities

<http://denali.gsfc.nasa.gov/dtam>

The Digital Tectonic Activity Map (DTEM) is a digital atlas of tectonism and volcanism of the last one million years. It is a compilation of field, geophysical and satellite measurements. The lithograph introduces the DTAM to the classroom, utilizing the map with online activities.

Recommended for: high school+.

Exploring Earth from Space: Lithograph Set and Instructional Materials, LS-2002-12-HQ

<http://spacelink.nasa.gov/products/Exploring.Earth>.

From Space

<http://catalog.core.nasa.gov/core.nsf/item/300.1-36P>

Space Shuttle astronauts and the EarthKAM program provide photos of our planet from the unique perspective of Earth's orbit. This resource can enhance students' studies of Earth and space science, geography, social

studies, mathematics and educational technologies. The set contains an educators' guide, student information and worksheets, and several Earth photos taken from the Space Shuttle. **Recommended for:** grades 3–12.

GOES Hurricane Linda

<http://www.gsfc.nasa.gov/gsfc/service/gallery/lithos/goes-linda.pdf>

This NASA lithograph presents a GOES satellite image of Hurricane Linda as it approached Baja, California on September 12, 1997. A brief explanation of how hurricanes are formed and a classroom exercise is on the back. **Recommended for:** middle–high school.

Landsat 7—New York City: Amelia's Adventures in New York City

<http://imagers.gsfc.nasa.gov/amelia/teachersguide/NYClitho>

This lithograph shows a Landsat 7 image of New York City and includes an activity for children ages 5–9. The imagery highlights vegetation, emphasizing location, shape and sizes of parks. The activity engages children in following Amelia the Pigeon's adventure around the parks in New York City. The lithograph is a companion piece to the *Amelia the Pigeon Interactive Adventure*—at <http://imagers.gsfc.nasa.gov/amelia>.

Recommended for: ages 5–10.

NASA FACTS

NASA Facts are educational brochures that provide general information and background on NASA-related missions, research topics and activities.

Choosing a Career in Atmospheric Sciences

<http://oea.larc.nasa.gov/PAIS/AtmSciCareer.html>

The following Earth science NASA Facts are available online at: http://eospsso.gsfc.nasa.gov/eos_homepage/for_educators/facts.php

- Clouds and the Energy Cycle—NF-207, August 1999
- El Niño—NF-211, August 1999
- Global Warming—NF-222, April 1998
- Polar Ice—NF-212, April 1998
- Tropical Deforestation—FS-1998-11-120-GSFC, November 1998

■ POSTERS

EOS Science Poster Series: Air, Land, Water and Ice

http://eospsso.gsfc.nasa.gov/eos_homepage/for_educators/eos_posters/index.php

Explore recent images and research results from NASA Earth science missions with these informative, eye-catching posters. Each poster takes a specific topic (air, land, water or ice) and explains what NASA scientists are doing to understand that topic. Colorful and instructional satellite images, graphs and pictures complement the fact-filled information making the posters ideal for the classroom. The posters can be ordered from the Web site provided; this site also includes PowerPoint and PDF files with the poster information. **Recommended for: middle school–post secondary.**

From the Top of the World to the Bottom of the Food Web

<http://www.bigelow.org/foodweb>
<http://catalog.core.nasa.gov/core.nsf/item/300.1-25P>

This educational wall sheet and associated Web site were developed by Bigelow Laboratory for Ocean Sciences to help teachers and students discover linkages among marine ecology, phytoplankton, the behavior of light at the ocean surface and satellite-derived ocean color data. The poster can be ordered from the Web sites listed above. **Recommended for: middle school+.**

Night Lights Poster

<http://catalog.core.nasa.gov/core.nsf/item/300.1-18P>

Much of Earth is illuminated at night by city lights. This NASA-produced poster shows a global view of Earth at night, compiled from over 400 satellite images collected during the nighttime phase of the orbit. Includes activities on the poster backside for elementary–secondary classes from Mission Geography (<http://missiongeography.org>). The poster can be ordered from the Web site provided. **Recommended for: K–12.**

SeaWiFS Poster with Teaching Supplement

<http://seawifs.gsfc.nasa.gov/SEAWIFS/TEACHERS>

This poster includes remote-sensing images from NASA's Sea-viewing Wide Field-of-View Sensor (SeaWiFS). The teaching supplement augments the poster with descriptive summaries of the variety of geophysical phenomena that can be seen in each image. The supplement also includes a glossary of terms and a listing of URLs for additional information. **Recommended for: upper high school–undergraduate.**

■ SLIDE SETS 35mm

Earthview

<http://catalog.core.nasa.gov/core.nsf/item/100.0-29>

This set of 4 slides presents photographs of Earth taken from four different Apollo missions (1969–1985). Provided by NASA's Public Affairs Office. Order from the Web site provided, item # 100.0-29, \$3.00.

Fragile Earth

<http://catalog.core.nasa.gov/core.nsf/item/100.0-26>

This slide set with script provides space photographs and satellite images that illustrate how both nature and people have changed Earth. Order from the Web site provided, item # 100.0-26, \$8.50.

Full Earth

<http://catalog.core.nasa.gov/core.nsf/item/100.0-30>

This slide set (6 slides) presents photographs of Earth taken from various Apollo missions and NASA's Applications Technology Satellite (ATS-3), 1968–1985. Provided by NASA's Public Affairs Office. Order from the Web site provided, item # 100.0-30, \$3.50.

The Ultimate Field Trip: An Astronaut's View of Earth

<http://catalog.core.nasa.gov/core.nsf/item/100.0-57>

This slide set and booklet includes a collection of 24 views of the Earth witnessed by NASA Astronaut Dr. Kathryn Sullivan while aboard the Space Shuttle. This material was adapted from a version published in *Update*, the newsletter of the National Geographic Society's Geography Education Program, Fall 1991. Order from NASA CORE at the Web site provided, item # 100.0-57, \$8.50. **Recommended for: middle–junior high school.**

United States Geography: United States Cities

<http://catalog.core.nasa.gov/core.nsf/item/100.0-54>

Sixty slides with descriptions of different US cities, offering photographs taken by astronauts aboard the Space Shuttle. Features cities, roads, airports and dams, as well as natural settings, including oceans, rivers, mountains and plains. The list accompanying each set contains the photo number by which additional prints can be ordered. Order from the Web site provided, item # 100.0-54, \$26.

The following regional slide sets are also available:

- **United States Geography: Appalachians, Ohio River Valley, Great Lakes**

<http://catalog.core.nasa.gov/core.nsf/item/100.0-50>
 20 slides with descriptions; item # 100.0-50, \$10.

- **United States Geography: East Coast States, New England to Florida**
http://catalog.core.nasa.gov/core.nsf/item/100.0-49
20 slides with descriptions; item # 100.0-49, \$10.
- **United States Geography: Great Plains and Mississippi River Valley**
http://catalog.core.nasa.gov/core.nsf/item/100.0-51
20 slides with descriptions; item # 100.0-51, \$10.
- **United States Geography: Rocky Mountains and Southwest**
http://catalog.core.nasa.gov/core.nsf/item/100.0-52
20 slides with descriptions; item # 100.0-52, \$10.
- **United States Geography: West Coast States, Alaska, and Hawaii**
http://catalog.core.nasa.gov/core.nsf/item/100.0-53
20 slides with descriptions; item # 100.0-53, \$10.

■ VIDEOTAPES

The following are videotapes related to NASA's ESE and are available for purchase from NASA CORE at the Web sites listed.

Blue Planet, 1990

Video—*http://catalog.core.nasa.gov/core.nsf/item/002.2-15V*

DVD—*http://catalog.core.nasa.gov/core.nsf/item/002.2-15D*

Filmed by astronauts from five Space Shuttle missions with an IMAX camera, this video dramatically reveals the forces affecting Earth's ecological balance: volcanoes, hurricanes, earthquakes and, ultimately, humankind. Experiments discussed in this videotape focus on infrared detection of atmospheric remnants from volcanic eruptions, ozone concentration levels and incoming solar ultraviolet radiation with respect to global warming. Order from NASA CORE at the Web sites provided; available in 1/2" VHS (Item # 002.2-15V, \$14.95) and DVD (Item # 002.2-15D, \$20). Length: 42:00.

Recommended for: grade 4–adult.

Catch the Wind: the QuikSCAT Video, 2001

http://catalog.core.nasa.gov/core.nsf/item/002.2-27V

Catch the Wind tells the story from inception to launch of NASA's quick scatterometer project (QuikSCAT), which gives a behind-the-scenes look at engineers, scientists and technicians working together to solve problems and successfully accomplish goals. Order from NASA CORE at the Web site provided, item # 002.2-27V, \$16. Length: 25:22.

Recommended for: middle school–adult.

Glacier Bay, Alaska, From the Ground, Air and Space, 1996

http://catalog.core.nasa.gov/core.nsf/item/002.2-16V

Bring glaciers to life with nine spectacular “fly-bys” of scenic rides over 3-dimensional glaciers, live video footage of ice fronts calving into the sea, and dramatic picture sequences of historical and satellite data. This video shows how a NASA glaciologist has learned about glaciers and how their formation could be related to climate change. Order from NASA CORE at the Web site provided, item # 002.2-16V, \$15. In addition to NASA CORE, this video is also available online at: *http://sdcd.gsfc.nasa.gov/GLACIER.BAY/glacierbay.story.html*. Length: 13:15. **Recommended for: grade 5–adult.**

Jason: An Ocean Odyssey Video, 2001

http://catalog.core.nasa.gov/core.nsf/item/002.2-23

Jason is joint U.S.-France oceanography mission to monitor global ocean circulation, discover the tie between the oceans and atmosphere, improve global climate predictions and monitor events such as El Niño conditions and ocean eddies. Jason-1 is a follow-on mission to the highly successful TOPEX/Poseidon mission. Order from NASA CORE at the Web site provided, item # 002.2-23, \$10. Length: 9:00. **Recommended for: grade 5–adult.**

Journeys through Earth and Space

Guide—*http://ct.gsfc.nasa.gov/journeys*

Video—*http://catalog.core.nasa.gov/core.nsf/item/002.2-33V*

Why are the Rocky Mountains so far inland? How do we preserve the changing Amazon rainforest? When will the Sun fling parts of itself towards Earth? The video magazine *Journeys through Earth and Space* follows three NASA research teams tackling these questions with supercomputers. Researcher interviews mix with scientific imagery and stunning nature footage. An accompanying *Video Resource Guide* provides background material and classroom activities for Grades 9–12. The Guide can be downloaded from *http://ct.gsfc.nasa.gov/journeys*—or ordered for \$3 from NASA CORE. Order videotape from NASA CORE at the Web site provided, item number 002.2-33V, \$15. Length: 18:00.

Recommended for: grades 9–12.

Liftoff to Learning: Geography From Space, 1997

http://catalog.core.nasa.gov/core.nsf/item/008.0-09V

This video takes the viewer on a rapid tour of Earth's surface as seen from the Space Shuttle. After explaining how the altitude of the viewer affects the amount of Earth's surfaces seen at one time, the video moves into a

travelogue on some of the interesting features of Earth's continents as seen from space. Order from NASA CORE at the Web site provided, item # 008.0-09V, \$15. Length: 15:00. **Recommended for:** elementary–middle school.

NASA CONNECT™

Data Analysis and Measurement: Ahead, Above the Clouds

<http://connect.larc.nasa.gov>

NASA CONNECT™ is a series of free, 30-minute, standards-based instructional distance learning programs for students in grades 5–8. In *Data Analysis and Measurement: Ahead, Above the Clouds*, students learn about hurricanes and how meteorologists, weather officers, and NASA researchers use measurement and data analysis to predict severe weather. Episodes are available from the NASA CONNECT™ Web site (http://connect.larc.nasa.gov/programs/2000-2001/ahead_clouds.html), or can be ordered on videotape from NASA CORE at <http://core.nasa.gov>.

NASA on the Cutting Edge: Our Water Planet from Space, 1998

<http://catalog.core.nasa.gov/core.nsf/item/002.2-21V>

Our *Water Planet from Space* is a videotape of two previously broadcast (1998) live interactive shows that explore the world's oceans. Order from NASA CORE at the Web site provided, item # 002.2-21V, \$16.00. Length: 60:00 (two 30:00 shows).

- *Program 1: Oceans in Motion*—Ocean circulation: how it works and the important role it plays in our lives.
- *Program 2: The Color of Oceans*—Ocean productivity, ecosystems and human impacts.

Recommended for: middle–high school.

NASA SCI Files™

<http://scifiles.larc.nasa.gov>

The NASA SCI Files™ distance learning series introduces students in grades 3–5 to NASA and integrates mathematics, science and technology through the use of Problem-Based Learning (PBL), scientific inquiry, and the scientific method. The programs can be viewed and videotaped at no cost on PBS-member TV stations and via satellite broadcast.

Episodes can also be viewed for free on the Internet via NASA's Learning Technologies channel: <http://quest.arc.nasa.gov/events/sci/index.html> and Knowitall.org at: http://www.knowitall.org/nasa/btml_wm/scifiles.html. You can also contact your local NASA Educator Resource Center (<http://education.nasa.gov/erc>) for a video copy or purchase an episode on videotape from NASA CORE at

<http://core.nasa.gov>. The following are Earth science shows that appeared on the NASA SCI Files™:

- *The Case of the Mysterious Red Light and The Case of the Phenomenal Weather*
<http://quest.arc.nasa.gov/events/sci/2001/index.html>
- *The Case of the Shakey Quake*
<http://quest.arc.nasa.gov/events/sci/2002/index.html>

Our Home: Earth from Space, 2002

<http://catalog.core.nasa.gov/core.nsf/item/002.2-31V>

Two student moderators engage the audience with satellite imagery, computer graphics and historical footage to make the point that the Earth is an interconnected system of air, land, water and life. The video includes the following segments: An Introduction to Earth System Science, Using Satellites to Look at Earth from Space, El Niño, Global Warming, Drought, Hurricanes and an Epilogue. Order from NASA CORE at the Web site provided, item # 002.2-31V, \$15. Length: 22:00. The video can also be downloaded as QuickTime movies from:

<http://edmall.gsfc.nasa.gov/video>.

Recommended for: high school.

SunSplash, 1997

<http://catalog.core.nasa.gov/core.nsf/item/002.2-18V>

SunSplash explains ozone depletion, using computer graphics and animation. The educational narrative explains how ozone in the stratosphere protects us from ultraviolet radiation and demonstrates how chlorofluorocarbons (CFCs) cause destruction of the Earth's protective ozone layer. Order from NASA CORE at the Web site provided, item # 002.2-18V, \$10. Length: 7:52.

Recommended for: high school.

UARS—The Upper Atmosphere Research Satellite Video and Resource Guide, 2001

<http://catalog.core.nasa.gov/core.nsf/item/002.2-26V>

This videotape was created to be a resource for helping to understand stratospheric ozone. The instruments aboard UARS and their measurements are described in the tape and how they help in studying humankind's influence on ozone. Order from NASA CORE at the Web site provided, item # 002.2-26V, \$15. Length: 17:00.

Recommended for: high school–undergraduate.

Underground Railroad: Connections to Freedom and Science, 1999

<http://catalog.core.nasa.gov/core.nsf/item/008.0-10V>

A collaboration between NASA and the National Park Service, this educational video details how the sciences of astronomy and geography guided slaves to freedom in the 1800s, and how the technologies of satellites and

geographic information systems are being used to locate and visualize the secret paths they traveled.

Using the North Star as a compass, freedom-seeking slaves went from safe house to safe house along the Underground Railroad, an intricate network of escape routes away from the slave-ridden South. This video explains the role celestial navigation played in the Railroad's success, and highlights the importance of modern technologies in reconstructing the exact routes and terrain of the Railroad. Order from NASA CORE at the Web site provided, item # 008.0-10V, \$16. Length: 34:00. **Recommended for: middle–high school.**

The Weather Watchers, 1977

<http://catalog.core.nasa.gov/core.nsf/item/002.3-02V>

This 1977 video provides historical footage regarding the importance of meteorological information obtained from NASA satellites for predicting and monitoring severe storms. Order from NASA CORE at the Web site provided, item # 002.3-02V, \$15. Length: 15:00.

Recommended for: grades 7–11.

■ WEB SITES

Destination Earth

<http://www.earth.nasa.gov>

Destination Earth is the official Web site for NASA's ESE. It includes current ESE news and events, sections on education for teachers and students and information on current research opportunities. Many links to other information resources are also included.

Earth Science Picture of the Day (EPOD)

<http://epod.usra.edu>

The EPOD Web site is a collaboration between NASA's Goddard Space Flight Center and the Universities Space Research Association. A new photograph or image highlighting an interesting or unusual aspect of the Earth's system appears every day. Each picture is accompanied by a detailed description and related links. Search the archive by keyword or browse by field or topic.

Recommended for: middle school+, informal education.

Earth Observatory

<http://earthobservatory.nasa.gov>

NASA's *Earth Observatory* is an interactive Web-based magazine where the science-attentive public can obtain new satellite imagery and scientific information about our home planet. Visit the *Earth Observatory* to read feature articles on wide-ranging Earth system science topics,

download datasets and images for analysis, read breaking news, learn about current and planned Earth missions, search an online library for reference materials, track natural hazards around the world in near-real time, and access interactive experiments and classroom activities.

Recommended for: general public, media, informal educators and middle school–post secondary instruction.

EOS Project Science Office

<http://eospsso.gsfc.nasa.gov>

The Earth Observing System (EOS) is the centerpiece of NASA's ESE. It is composed of a series of satellites, a science component and a data system supporting a coordinated series of satellites for long-term global observations of the land surface, biosphere, solid Earth, atmosphere and oceans. The EOS Project Science Office is committed to bringing program information and resources to program scientists and the general public alike. Visit the project's Web site to find resources for educators, including educational links and publications from the EOS program. **Recommended for: elementary–secondary educators, undergraduate–graduate.**

NASA Earth Science Missions—Education Programs and Resources

Many of NASA's Earth science missions have an education and/or public outreach component. These efforts include a wide variety of activities and resources for educators, students and the public, including teacher workshops, public programs and events, and curriculum and classroom materials. Visit the Web sites listed with each mission for specific information on a mission's programs and resources, including access to satellite imagery and other data. Missions are listed by year of launch or scheduled launch.

TOPEX/Poseidon

<http://sealevel.jpl.nasa.gov/education/education.html>

Jointly sponsored by NASA and CNES, the French space agency, the TOPEX/Poseidon satellite uses radar altimeters to continuously survey ocean surface height. The Jason-1 satellite joined TOPEX/Poseidon in orbit in 2001 to collect similar data.

Scientists are using TOPEX/Poseidon and Jason-1 data to learn more about global ocean circulation patterns, including phenomena such as El Niño/La Niña. Oceans are a key mechanism in transporting heat from the Sun around the globe. Researchers are working to improve understanding of the role oceans play in controlling seasonal variations and longer-term climate changes. Ocean altimetry data are also used for operational purposes, including ship routing, fisheries man-

agement, hurricane forecasting and support of underwater activities like cable laying. **CONTACT:** Annie Richardson or Mona Jasnow, Jet Propulsion Laboratory, **Email:** topex@jpl.nasa.gov. (Launched: 1992)

SeaWiFS

<http://seawifs.gsfc.nasa.gov/SEAWIFS/TEACHERS>

The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) is providing quantitative data on global ocean bio-optical properties. Subtle changes in ocean color signify various types and quantities of marine phytoplankton (microscopic marine plants), the knowledge of which has both scientific and practical applications. SeaWiFS has helped us to not only monitor the short-term spatial and temporal variability in the ocean's biology, but also to have the first well-calibrated, long-term data set that allows us to quantify the ocean's biological response to global change. (Launched: 1997)

Tropical Rainfall Measuring Mission (TRMM)

<http://trmm.gsfc.nasa.gov>

<http://strategies.org/TRMM.html>

TRMM is a joint mission between NASA and the National Space Development Agency of Japan (NASDA). It is designed to monitor and study tropical rainfall and the associated release of energy that helps to power the global atmospheric circulations shaping both weather and climate around the world. **CONTACT:** Jeffrey Halverson, TRMM Education and Outreach Scientist, Code 912, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6333, **Email:** halverson@agnes.gsfc.nasa.gov. (1997 launch)

ACRIMSAT

<http://acrim.jpl.nasa.gov/education/eduindex.html>

Using the Active Cavity Radiometer Irradiance Monitor (ACRIM) III instrument, the ACRIMSAT spacecraft provides long-term, precise measurements of the total amount of the Sun's energy that falls on our planet's surface, oceans and atmosphere. ACRIM I was the first instrument to clearly show that the energy from the Sun is not a constant value but instead varies over time. These energy changes are small but significant, and they cycle approximately every 11 years. ACRIMSAT data is vital to helping scientists build more accurate climate models. (Launched: 1999)

Landsat 7

<http://landsat.gsfc.nasa.gov/main/education.html>

The Landsat 7 satellite is acquiring remotely-sensed images of land surface and coastal regions for global change research, regional environmental change studies, national security uses and other civil and commer-

cial purposes. The Landsat 7 data set will provide the first high-resolution view of both seasonal and interannual changes in the terrestrial environment. **CONTACT:** Stephanie Stockman, Code 921, NASA Goddard Space Flight Center, **Phone:** 301-614-6457, **Email:** stockman@core2.gsfc.nasa.gov. (Launched: 1999)

SeaWinds on QuikSCAT

<http://winds.jpl.nasa.gov/education>

The SeaWinds instrument on the QuikSCAT satellite is a "quick recovery" effort to fill the gap created by the loss of data from the NASA Scatterometer (NSCAT) when the satellite lost power in June of 1997. SeaWinds is a specialized microwave radar that measures near-surface wind speed and direction over the Earth's oceans under all weather and cloud conditions. **CONTACT:** Peter Falcon, Scatterometer Projects Outreach Coordinator, Jet Propulsion Laboratory, 4800 Oak Grove Dr., MS TR 1722-114, Pasadena, CA 91109-8099, **Phone:** 818-393-0729, **Fax:** 818-354-8813, **Email:** pcfalcon@pop.jpl.nasa.gov. (Launched: 1999)

Terra

<http://terra.nasa.gov>

Terra, the flagship satellite of NASA's Earth Observing System, is collecting what will ultimately become a new, 15-year global data set on the state of the land, oceans and atmosphere. Data from this mission are used in many research and commercial applications. **CONTACT:** David Herring, Code 913, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6219, **Email:** dherring@climate.gsfc.nasa.gov. (Launched: 1999)

EO-1

<http://eo1.gsfc.nasa.gov/Education/eo1Education.html>

Earth Observing-1 (EO-1) is the first flight of NASA's New Millennium Program (NMP). Its mission is to validate technologies that will reduce the cost and increase capabilities of upcoming land-imaging missions. As a result of EO-1, future spacecraft will be an order of magnitude smaller and lighter than current versions. **CONTACT:** Joseph Young, EO-1 Mission Technology Transfer Manager, NASA Goddard Space Flight Center, **Phone:** 301-286-8146, **Email:** joseph.p.young.1@gsfc.nasa.gov. (Launched: 2000)

Jason-1

<http://sealevel.jpl.nasa.gov/education/education.html>

Jointly sponsored by NASA and CNES, the French space agency, Jason-1 is a follow-on mission to TOPEX/Poseidon. See TOPEX/Poseidon (1992 launch) listing on p. 18 for additional details. (Launched: 2001)

SAGE III/METEOR-3M

<http://www-sage3.larc.nasa.gov>

The Stratospheric Aerosol and Gas Experiment (SAGE) III mission on the Russian Meteor-3M spacecraft seeks to enhance our understanding of natural and human-derived atmospheric processes by providing high-latitude, long-term measurements of the vertical structure of aerosols, ozone, water vapor and other important trace gases in the upper troposphere and stratosphere. **CONTACT:** David Woods, NASA Langley Research Center, Hampton, VA 23681, **Email:** d.c.woods@larc.nasa.gov. (Launched: 2001)

Aqua

<http://aqua.nasa.gov>

Latin for "water," Aqua is named for the large amount of information the mission is collecting about the Earth's water cycle, including evaporation from the oceans, water vapor in the atmosphere, clouds, precipitation, soil moisture, sea ice, land ice and snow cover on land and ice. Additional variables also being measured by Aqua include radiative energy fluxes, aerosols, vegetation cover on land, phytoplankton and dissolved organic matter in the oceans and air, land and water temperatures. **CONTACTS:** Claire Parkinson, Code 971, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-5715, **Email:** claire.l.parkinson@nasa.gov; Steve Graham, Code 900, NASA Goddard Space Flight Center, **Phone:** 301-614-5561, **Email:** steven.m.graham.2@gsfc.nasa.gov. (Launched: 2002)

GRACE

<http://www.csr.utexas.edu/grace/education>

The second of the Pathfinder missions, the Gravity Recovery and Climate Experiment (GRACE) employs a satellite-to-satellite microwave tracking system to measure the Earth's gravity field and its variability over time. Such measurements are directly coupled to long-wavelength ocean circulation processes and to the transport of ocean heat to the Earth's poles. **CONTACT:** **Email:** grace_edu@tsgc.utexas.edu. (Launched: 2002)

SeaWinds on ADEOS II

<http://winds.jpl.nasa.gov/education>

The Advanced Earth Observing Satellite (ADEOS) II is a joint mission with the National Space Development Agency of Japan (NASDA). The SeaWinds scatterometer is a specialized microwave radar that measures near-surface wind velocity (both speed and direction) over the Earth's oceans under all weather and cloud conditions. **CONTACT:** Peter Falcon, Scatterometer Projects Outreach Coordinator, Jet

Propulsion Laboratory, 4800 Oak Grove Dr., MS TR 1722-114, Pasadena, CA 91109-8099, **Phone:** 818-393-0729, **Fax:** 818-354-8813, **Email:** pcfalcon@pop.jpl.nasa.gov. (Launched: 2002)

ICESat

<http://icesat.gsfc.nasa.gov/publicoutreach.html>

The Ice, Cloud and Land Elevation Satellite (ICESat) operates the Geoscience Laser Altimeter System (GLAS). GLAS is accurately measuring the elevation of the Earth's ice sheets, clouds and land. Data is available from the National Snow and Ice Data Center (<http://nsidc.org/daac/icesat>). **CONTACT:** **Email:** webmaster@icesat0.gsfc.nasa.gov. (Launched: 2003)

SORCE

http://lasp.colorado.edu/sorce/edu_outreach.html

The Solar Radiation and Climate Experiment (SORCE) mission is providing state-of-the-art measurements of incoming x-ray, ultraviolet, visible, near-infrared and total solar radiation. The measurements provided by SORCE specifically address long-term climate change, natural variability and enhanced climate prediction, as well as atmospheric ozone and UV-B radiation. These measurements are critical to studies of the Sun and its effect on the Earth system. **CONTACT:** Gary Rottman, Laboratory for Atmospheric and Space Physics, Campus Box 590, University of Colorado, Boulder, CO 80309-0590, **Phone:** 303-492-8324, **Email:** gary.rottman@lasp.colorado.edu. (Launched: 2003)

Aura

<http://aura.gsfc.nasa.gov/outreach>

Aura will study the Earth's ozone, air quality and climate. The mission is designed exclusively to conduct research on the composition, chemistry and dynamics of the Earth's upper and lower atmosphere. **CONTACT:** Stephanie Stockman, Code 921, NASA Goddard Space Flight Center, **Email:** stockman@core2.gsfc.nasa.gov. (Scheduled launch: 2004)

GIFTS

<http://tellus.ssec.wisc.edu/outreach/gifts/gifts.htm>

The Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS) will make revolutionary advances in weather observations and potentially improve weather forecasts by making vertical and horizontal measurements of winds, water vapor and temperature in the Earth's atmosphere from a geosynchronous orbit. **CONTACT:** Arlene Levine, NASA Langley Research Center, Hampton, VA 23681-0001, **Phone:** 757-864-3318, **Email:** a.s.levine@larc.nasa.gov. (Scheduled launch: 2005)

CALIPSO

<http://www-calipso.larc.nasa.gov/outreach>

The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite will produce the first global three-dimensional view of aerosols and clouds. It will improve our understanding of the role aerosols and clouds play in the processes that govern climate responses and feedbacks, and improve the representation of aerosols and clouds in models, leading to more accurate predictions of climate change.

Accurate climate model predictions will provide international and national leaders with reliable information to make more informed policy decisions about global climate change. CALIPSO will fly in formation with Cloudsat (see next listing) and other satellites.

CONTACTS: Dianne Robinson, Outreach Director for CALIPSO, Interdisciplinary Science Center (ISC), Hampton University, **Email:** dianne.robinson@hamptonu.edu; Barbara Maggi, Assistant Outreach Director for CALIPSO, Center for Atmospheric Sciences (CAS), Hampton University, **Email:** barbara.maggi@hamptonu.edu. (Scheduled launch: 2005)

CloudSat

<http://cloudsat.atmos.colostate.edu/outreach>

CloudSat will provide vertical profiling from space of the full range of clouds, from thin cirrus to thick, precipitating convective clouds. It will also provide the first quantitative estimates of ice in clouds. The mission will fill a critical gap in the investigation of feedback mechanisms linking clouds to climate. CloudSat will orbit in formation as part of a constellation of satellites including Aqua, Aura and CALIPSO. One of the unique features that CloudSat brings to this constellation is the ability to fly a precise orbit, enabling the footprint of the CloudSat radar to be overlapped with that of the CALIPSO lidar, as well as with other instruments in the constellation. The precision of this overlap creates a unique multi-satellite observing system for studying atmospheric processes essential to the hydrological cycle. **CONTACT:** Debra Krumm, Outreach Coordinator, Department of Atmospheric Science, Colorado State University, Fort Collins, CO 80523-1371, **Phone:** 970-491-8790, **Email:** dkrumm@atmos.colostate.edu. (Scheduled launch: 2005.)

PUMAS (Practical Uses of Math and Science)

<http://pumas.jpl.nasa.gov>

PUMAS is the online journal of one-page examples illustrating how math and science concepts are actually used in everyday life. PUMAS examples may be activities, anecdotes, descriptions of neat ideas, formal exercises, puzzles or demonstrations, written primarily by scientists. They are intended mainly to help K–12 teachers enrich their presentation of science and math in the classroom. Teachers can search the PUMAS collection based on curriculum topic, grade level, and subject. They can select relevant examples, and develop ideas of their own about how to integrate the material into their lesson plans.

Recommended for: K–12 teachers.

Higher Education

Instructional Materials/Courses 22

Resources

Books 23
 Brochures 23
 Earth Science Data & Imagery 24
 Web Sites 25

Instructional Materials/Courses

CEOS Resources in Earth Observation

<http://ceos.cnes.fr:8100/cdrom-98/astart.htm>

The international Committee on Earth Observation Satellites (CEOS) has produced this resource, which contains case studies (examples of Earth observation applications to real-life problems), data and information for education and developing countries. **Recommended for: high school, undergraduate, graduate—professional.**

Chesapeake Bay from Space

<http://chesapeake.towson.edu>

This Web site provides a wide variety of data and tools designed to introduce decision makers to the use and interpretation of Landsat 7 imagery, primarily focusing on imagery used to measure the extent of impervious surfaces—land covers that repel water, restrict groundwater recharge, generate large volumes of storm water and degrade water quality—in the Chesapeake Bay and Maryland Coastal Bays Watersheds. It includes Landsat data and a variety of background information and tools designed for users outside the research community, including urban planning professionals, educators and the general public. **Recommended for: post secondary, state and local government officials.**

Climate Change Presentation Kit, 1999

<http://www.epa.gov/enviroed/globalclimate.html>

The Climate Change Presentation Kit is offered as a resource to help prepare talks for students or the general public. The toolkit allows teachers the option of picking and choosing the components that they would need to communicate climate change issues to audiences. It contains fact sheets, a PowerPoint slide presentation and interactive activities that are designed to interest audiences of all levels. Order this free CD-ROM at the Web site provided.

Recommended for: elementary—college educators, informal educators.

Earth System Science Online Courses for K–12 Teachers

<http://www.cet.edu/essea>

K–12 Earth system science (ESS) online graduate courses have been developed within the Center for Educational Technology (CET) at Wheeling Jesuit University for NASA's Earth Science Enterprise. The Earth system science courses use an innovative instructional design model, are delivered over the Internet and feature student-centered, knowledge-building virtual communities. To view the courses, go to the Web site provided and click on the link for "ESSEA Courses." To find a college or university offering the courses, click on the link for "Course Offerings."

Recommended for: K–12 teacher education.

Geomorphology from Space, 1986

http://daac.gsfc.nasa.gov/DAAC_DOCS/geomorphology/GEO_HOME_PAGE.html
<http://core.nasa.gov/core.nsf/item/400.0-87>

Available on CD and the Web, *Geomorphology from Space* was designed for studying landforms and landscapes. It contains a gallery of 237 color and black and white plates of space imagery, primarily of the Earth, each treating a geographic region where a particular landform theme is exemplified. Each image is paired with a detailed scientific description of the features in the image; some images are accompanied by line drawings, locator maps, geologic maps and on-the-ground photographs of the landform. Available on CD-ROM from NASA CORE at the Web site provided.

Recommended for: high school—adult.

Studying Earth's Environment from Space

<http://www.ccpo.odu.edu/SEES/index.html>

This material consists of four modules designed to increase the use of satellite data in science classrooms: *Stratospheric Ozone*, *Global Land Vegetation*, *Oceanography* and *Polar Sea Ice Processes*. Lecture materials are provided, including full-color, printable graphics that are linked to guided-inquiry computer exercises. The software package used for the computer exercises is SEE Image, which is a modified version of NIH-Image. The software runs on Macintosh computers, as well as PCs that are equipped with a Macintosh emulator.

Recommended for: high school—undergraduate.

World Watcher: Global Warming Project

<http://www.worldwatcher.northwestern.edu/curriculumMS.htm>

Global warming and its potential impact provide the context for this unit, in which students learn about the scientific

factors contributing to the debate. Students act as advisors to the heads of state of several nations, and explore the issues as they respond to the various questions and concerns of these leaders. Activities include a combination of physical labs and investigations using World Watcher software, a geographic data visualization tool. Developed by Northwestern University. **Recommended for: middle school+.**

Resources

BOOKS

Earth from Above: Using Color-Coded Satellite Images to Examine the Global Environment, 1997

<http://www.uscibooks.com>

Written by NASA Goddard Space Flight Center scientist Claire Parkinson, *Earth from Above* provides an easy introduction to understanding and interpreting satellite images. Beginning with two short chapters on visible satellite images and radiation, the book then covers six key Earth-atmosphere variables on topics including the Antarctic ozone hole, El Niño, deforestation, the missing carbon dilemma, and the effects of sea ice, snow cover and volcanoes on atmospheric temperatures. A final chapter broadens the discussion to consider satellite Earth observations in general. Each section concludes with a list of questions; answers are provided at the back of the book. Available for purchase from University Science Books at the Web site provided.

Recommended for: post secondary.

Ecosystem Change and Public Health: A Global Perspective

http://www.press.jhu.edu/books/title_pages/1495.html

This textbook was published by Johns Hopkins University Press to: 1) raise awareness of changes in human health related to global ecosystem change; and 2) expand the scope of the traditional curriculum in environmental health to include the interactions of major environmental forces and public health on a global scale. The book covers such topics as global climate change, stratospheric ozone depletion, water resources management and ecology and infectious disease. Case studies of cholera, malaria, the effects of water resources and global climate change and air pollution illustrate the analysis and methodology. The book also includes a resource center describing places to start searches on the Web, guide-

lines for finding and evaluating information, suggested study projects and strategies for encouraging communication among course participants.

Recommended for: undergraduate.

EOS Science Plan, 1999

http://eosps0.gsfc.nasa.gov/science_plan/index.php

The purpose of this plan is to state the concerns and problems facing Earth science today, and to indicate contributions that will be made toward providing solutions to those problems, primarily through the use of satellite-based observations that will be obtained with NASA EOS satellites and instruments. Seven topical chapters discuss the nature of the science being reviewed: radiation, clouds, water vapor, precipitation and atmospheric circulation; ocean circulation, productivity and exchange with the atmosphere; greenhouse gases and atmospheric chemistry; land ecosystems and hydrology; cryospheric systems; ozone and stratospheric chemistry; and volcanoes and climate effects of aerosols.

Recommended for: post secondary.

Atlas of the Ocean: The Deep Frontier, 2001

<http://shop.nationalgeographic.com>

Featuring more than 150 photographs, maps and NASA satellite images, this atlas charts and celebrates every aspect of the ocean world, from tiny plankton to massive storm systems that rage across thousands of miles. Experts have contributed essays and sidebars on subjects as diverse as deep-sea archeology, plate tectonics, coral reefs, mapping techniques and El Niño. Readers also go behind the scenes to observe modern science at work, as researchers pursue promising leads in dozens of different but intertwined fields. Order online at the Web site provided—or from National Geographic Society, 1145 17th Street NW, Washington, DC 20036-4688.

Recommended for: formal and informal education audiences, grade 8–adult.

BROCHURES

Aqua Brochure

http://eosps0.gsfc.nasa.gov/ftp_docs/Aqua_brochure.pdf

"Aqua," Latin for "water," is a NASA satellite mission named for the large amount of information that it is collecting about the Earth's water cycle, including evaporation from the oceans, water vapor in the atmosphere, clouds, precipitation, soil moisture, sea ice, land ice and snow cover on the land and ice. Additional variables also being measured by Aqua include radiative energy fluxes,

aerosols, land vegetation cover, phytoplankton and dissolved organic matter in the oceans and air, land and water temperatures. This brochure provides a comprehensive overview of the Aqua spacecraft, instruments, science and data products. **Recommended for: post secondary and as a resource for informal educators.**

CERES—Clouds and the Earth's Radiant Energy System Brochure

http://eosps.gsfc.nasa.gov/eos_homepage/brochures/CERES.php

This brochure gives a brief description of the science research that is being done with data from the CERES instrument flying onboard NASA's Terra satellite. It also contains information about some of the data products and technical specifications. **Recommended for: undergraduate, graduate and professional.**

GRACE Brochure

http://eosps.gsfc.nasa.gov/ftp_docs/GRACE.pdf

Gravity controls everything from the motion of the ocean tides to the expansion of the entire universe. To learn more about the mysteries of gravity, twin NASA satellites named GRACE, short for the Gravity Recovery and Climate Experiment, are making detailed measurements of Earth's gravity field. This experiment could lead to discoveries about gravity and Earth's natural systems, which could have substantial benefits for society and the world's population. **Recommended for: post secondary and resource for informal educators.**

ICESat: Ice, Cloud, and land Elevation Satellite

http://icesat.gsfc.nasa.gov/ICESat_Brochure.pdf

The mission brochure for NASA's ICESat, which was launched January 12, 2003. ICESat is the benchmark Earth Observing System mission for measuring ice sheet mass balance, cloud and aerosol heights, as well as land topography and vegetation characteristics.

Recommended for: college/university instructors and students; informal educators.

Measurements of Pollution in the Troposphere (MOPITT) Brochure

http://eosps.gsfc.nasa.gov/ftp_docs/MOPITT_broch.pdf

This brochure gives a brief description of the science research that is being done with data from the MOPITT instrument flying onboard NASA's Terra satellite. It also identifies some of the data products, as well as gives some technical specifications. **Recommended for: undergraduate, graduate—professionals.**

MODIS Brochure

http://eosps.gsfc.nasa.gov/ftp_docs/MODIS.pdf

The first NASA Earth Observing System (EOS) satellite, called Terra, was launched on December 18, 1999, carrying five remote sensors. The most comprehensive EOS sensor is MODIS, the Moderate Resolution Imaging Spectroradiometer. MODIS offers a unique combination of features: it detects a wide spectral range of electromagnetic energy; it takes measurements at three spatial resolutions (levels of detail); it takes measurements all day, every day; and it has a wide field of view. This continual, comprehensive coverage allows MODIS to complete an electromagnetic picture of the globe every two days.

Recommended for: post secondary and resource for informal educators.

■ EARTH SCIENCE DATA & IMAGERY

See also the section that follows—Web Sites—for a list of individual Earth science missions.

Earth Observatory

<http://earthobservatory.nasa.gov>

NASA's Earth Observatory is an interactive Web-based magazine where the science-attentive public can obtain new satellite imagery and scientific information about our home planet. Visit the Earth Observatory to read feature articles on wide-ranging Earth system science topics, download datasets and images for analysis, read breaking news, learn about current and planned Earth missions, search an online library for reference materials, track natural hazards around the world in near-real time, and access interactive experiments and classroom activities.

Recommended for: general public, media, informal educators and middle school—post secondary instruction.

EOSDIS Resources

The following resources from the EOSDIS (Earth Observing System Data and Information System) are recommended for advanced undergraduate and graduate education:

- EOSDIS Data Sampler #1: Western U.S. Wildfires 2000, Version 2
http://ivanova.gsfc.nasa.gov/outreach/EOSDIS_CD_01_v2/start.htm
- EOSDIS Data Sampler #2: Mount Oyama Volcanic Eruptions 2000, Version 1
http://ivanova.gsfc.nasa.gov/outreach/EOSDIS_CD-02/start.htm
- EOSDIS Posters: Geologists' Tools in Space; Mount Oyama Erupts!; Ocean and Land...Struggling for

Mastery; The Great Barrier Reef; Spin Cycle; Hurricane Energetics; Wildfire!; and August 2000 Terra Views Idaho-Montana Fires
<http://ivanova.gsfc.nasa.gov/outreach/posters.html>

- Living with Volcanoes Folder
<http://ivanova.gsfc.nasa.gov/outreach/folders.html>

Gateway to Astronaut Photography of Earth

<http://eol.jsc.nasa.gov>

This Web site hosts the best and most complete online collection of astronaut photographs of the Earth, including over 480,000 photos from Space Shuttle and the International Space Station. Users can search the database of photos by geographic coordinates or region, mission, features, cloud cover and many other options. The site also features an image of the week, as well as special collections of images, including: Cities, Earth Landscape, Earth-Human Interaction, Distinctive Features, Hurricanes and Weather, Earth's Water Habitat and Geographical Regions.

NASA Distributed Active Archive Centers (DAACs)

<http://nasadaacs.eos.nasa.gov>

The NASA DAACs are the data management and user services branches of NASA's Earth Observing System Data and Information System (EOSDIS). The DAACs process, archive, document and distribute data from NASA's past and current Earth science research satellites and field measurement programs. They were established in the early 1990s, and each DAAC serves a specific science discipline. The DAAC Alliance publishes annual feature articles (<http://nasadaacs.eos.nasa.gov/year-books/index.html>) on how these data sets are being used for wide-ranging science research and applications purposes.

Recommended for: high school educators, undergraduate, graduate—professional.

Landsat-7 Datasets: LAN Files for Use with MultiSpec

<http://landsat.gsfc.nasa.gov/education/l7/downloads/index.html>

This site provides a number of Landsat 7 scene subsets as LAN files that are intended for use with Purdue University's MultiSpec software. Users also have the option of downloading the Landsat images as TIFF files in four different band combinations. Links are included to download MultiSpec, a MultiSpec tutorial, and an introduction to remote-sensing PowerPoint presentation with detailed notes. **Recommended for:** middle school—undergraduate.

United States of America Digital Landsat Mosaics: a 4-CD set of Landsat satellite imagery of the fifty states

<http://catalog.core.nasa.gov/core.nsf/item/400.1-52>

Using the US Digital Landsat Mosaics, we can increase our understanding of Earth system science and the effects humans have on the global environment. The mosaics were developed primarily from data collected by the Landsat 4 and Landsat 5 satellites as they orbited the Earth ten or more years ago. This historical imagery is a valuable record of the conditions on Earth around 1990. The CD was developed by NASA Stennis Space Center and the US Geological Survey. It also includes a basic Landsat tutorial. **Recommended for:** high school—adult.

Visible Earth

<http://visibleearth.nasa.gov>

This companion site to the NASA *Earth Observatory* (<http://earthobservatory.nasa.gov>) is a comprehensive image gallery for access to NASA Earth science images, animations and data visualizations. Most resources are available digitally at multiple resolutions, with captions and metadata. **Recommended for:** media and general public.

■ WEB SITES

Destination Earth

<http://www.earth.nasa.gov>

Destination Earth is the official Web site for ESE. It includes current ESE news and events, sections on education for teachers and students and information on current research opportunities. Many links to other information resources are also included.

Earth Science Picture of the Day (EPOD)

<http://epod.usra.edu>

The EPOD Web site is a collaboration between NASA's Goddard Space Flight Center and the Universities Space Research Association. A new photograph or image highlighting an interesting or unusual aspect of the Earth's system appears every day. Each picture is accompanied by a detailed description and related links. Search the archive by keyword or browse by field or topic. **Recommended for:** middle school+, informal education.

Earth Observatory

<http://earthobservatory.nasa.gov>

NASA's *Earth Observatory* is an interactive Web-based magazine where the science-attentive public can obtain new satellite imagery and scientific information about

our home planet. Visit the *Earth Observatory* to read feature articles on wide-ranging Earth system science topics, download datasets and images for analysis, read breaking news, learn about current and planned Earth missions, search an online library for reference materials, track natural hazards around the world in near-real time, and access interactive experiments and classroom activities.

Recommended for: general public, media, informal educators, and middle school–post secondary instruction.

EOS Project Science Office

<http://eospsoc.gsfc.nasa.gov>

The Earth Observing System (EOS) is the centerpiece of NASA's ESE. It is composed of a series of satellites, a science component and a data system supporting a coordinated series of satellites for long-term global observations of the land surface, biosphere, solid Earth, atmosphere and oceans. The EOS Project Science Office is committed to bringing program information and resources to program scientists and the general public alike. Visit the project's Web site to find resources for educators, including educational links and publications from the EOS program. **Recommended for:** elementary–secondary educators, undergraduate–graduate.

NASA Earth Science Missions—Education and Public Outreach

Many of NASA's Earth science missions have an education and/or public outreach component. These efforts include a wide variety of activities and resources for educators, students and the public, including teacher workshops, public programs and events and curriculum and classroom materials. Visit the Web sites listed with each mission for specific information on a mission's programs and resources, including access to satellite imagery and other data. Missions are listed by year of launch or scheduled launch.

TOPEX/Poseidon

<http://sealevel.jpl.nasa.gov/education/education.html>

Jointly sponsored by NASA and CNES, the French space agency, the TOPEX/Poseidon satellite uses radar altimeters to continuously survey ocean surface height. The Jason-1 satellite joined TOPEX/Poseidon in orbit in 2001 to collect similar data.

Scientists are using TOPEX/Poseidon and Jason-1 data to learn more about global ocean circulation patterns, including phenomena such as El Niño/La Niña. Oceans are a key mechanism in transporting heat from the Sun around the globe. Researchers are working to improve understanding of the role oceans play in controlling seasonal variations and longer-term climate

changes. Ocean altimetry data are also used for operational purposes, including ship routing, fisheries management, hurricane forecasting and support of underwater activities like cable laying. **CONTACT:** Annie Richardson or Mona Jasnow, Jet Propulsion Laboratory, **Email:** topex@jpl.nasa.gov. (Launched: 1992)

SeaWiFS

<http://seawifs.gsfc.nasa.gov/SEAWIFS/TEACHERS>

The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) is providing quantitative data on global ocean bio-optical properties. Subtle changes in ocean color signify various types and quantities of marine phytoplankton (microscopic marine plants), the knowledge of which has both scientific and practical applications. SeaWiFS has helped us to not only monitor the short-term spatial and temporal variability in the ocean's biology, but also to have the first well-calibrated, long-term data set that allows us to quantify the ocean's biological response to global change. (Launched: 1997)

Tropical Rainfall Measuring Mission (TRMM)

<http://trmm.gsfc.nasa.gov>

<http://strategies.org/TRMM.html>

TRMM is a joint mission between NASA and the National Space Development Agency of Japan (NASDA). It is designed to monitor and study tropical rainfall and the associated release of energy that helps to power the global atmospheric circulations shaping both weather and climate around the world. **CONTACT:** Jeffrey Halverson, TRMM Education and Outreach Scientist, Code 912, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6333, **Email:** halverson@agnes.gsfc.nasa.gov. (1997 launch)

ACRIMSAT

<http://acrim.jpl.nasa.gov/education/eduindex.html>

Using the Active Cavity Radiometer Irradiance Monitor (ACRIM) III instrument, the ACRIMSAT spacecraft provides long-term, precise measurements of the total amount of the Sun's energy that falls on our planet's surface, oceans and atmosphere. ACRIM I was the first instrument to clearly show that the energy from the Sun is not a constant value but instead varies over time. These energy changes are small but significant, and they cycle approximately every 11 years. ACRIMSAT data is vital to helping scientists build more accurate climate models. (Launched: 1999)

Landsat 7

<http://landsat.gsfc.nasa.gov/main/education.html>

The Landsat 7 satellite is acquiring remotely-sensed images of land surface and coastal regions for global change research, regional environmental change stud-

ies, national security uses and other civil and commercial purposes. The Landsat 7 data set will provide the first high-resolution view of both seasonal and interannual changes in the terrestrial environment. **CONTACT:** Stephanie Stockman, Code 921, NASA Goddard Space Flight Center, **Phone:** 301-614-6457, **Email:** stockman@core2.gsfc.nasa.gov. (Launched: 1999)

SeaWinds on QuikSCAT

<http://winds.jpl.nasa.gov/education>

The SeaWinds instrument on the QuikSCAT satellite is a "quick recovery" effort to fill the gap created by the loss of data from the NASA Scatterometer (NSCAT) when the satellite lost power in June of 1997. SeaWinds is a specialized microwave radar that measures near-surface wind speed and direction over the Earth's oceans under all weather and cloud conditions. **CONTACT:** Peter Falcon, Scatterometer Projects Outreach Coordinator, Jet Propulsion Laboratory, 4800 Oak Grove Dr., MS TR 1722-114, Pasadena, CA 91109-8099, **Phone:** 818-393-0729, **Fax:** 818-354-8813, **Email:** pcfalcon@pop.jpl.nasa.gov. (Launched: 1999)

Terra

<http://terra.nasa.gov>

Terra, the flagship satellite of NASA's Earth Observing System, is collecting what will ultimately become a new, 15-year global data set on the state of the land, oceans and atmosphere. Data from this mission are used in many research and commercial applications. **CONTACT:** David Herring, Code 913, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6219, **Email:** dherring@climate.gsfc.nasa.gov. (Launched: 1999)

EO-1

<http://eo1.gsfc.nasa.gov/Education/eo1Education.html>

Earth Observing-1 (EO-1) is the first flight of NASA's New Millennium Program (NMP). Its mission is to validate technologies that will reduce the cost and increased capabilities of upcoming land-imaging missions. As a result of EO-1, future spacecraft will be an order of magnitude smaller and lighter than current versions. **CONTACT:** Joseph Young, EO-1 Mission Technology Transfer Manager, NASA Goddard Space Flight Center, **Phone:** 301-286-8146, **Email:** joseph.p.young.1@gsfc.nasa.gov. (Launched: 2000)

Jason-1

<http://sealevel.jpl.nasa.gov/education/education.html>

Jointly sponsored by NASA and CNES, the French space agency, Jason-1 is a follow-on mission to TOPEX/Poseidon. See TOPEX/Poseidon (1992 launch) listing on p. 25 for additional details. (Launched: 2001)

SAGE III/METEOR-3M

<http://www-sage3.larc.nasa.gov>

The Stratospheric Aerosol and Gas Experiment (SAGE) III mission on the Russian Meteor-3M spacecraft seeks to enhance our understanding of natural and human-derived atmospheric processes by providing high-latitude, long-term measurements of the vertical structure of aerosols, ozone, water vapor and other important trace gases in the upper troposphere and stratosphere. **CONTACT:** David Woods, NASA Langley Research Center, Hampton, VA 23681, **Email:** d.c.woods@larc.nasa.gov. (Launched: 2001)

Aqua

<http://aqua.nasa.gov>

Latin for "water," Aqua is named for the large amount of information the mission is collecting about the Earth's water cycle, including evaporation from the oceans, water vapor in the atmosphere, clouds, precipitation, soil moisture, sea ice, land ice and snow cover on land and ice. Additional variables also being measured by Aqua include radiative energy fluxes, aerosols, vegetation cover on land, phytoplankton and dissolved organic matter in the oceans and air, land and water temperatures. **CONTACTS:** Claire Parkinson, Code 971, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-5715, **Email:** claire.l.parkinson@nasa.gov; Steve Graham, Code 900, NASA Goddard Space Flight Center, **Phone:** 301-614-5561, **Email:** steven.m.graham.2@gsfc.nasa.gov. (Launched: 2002)

GRACE

<http://www.csr.utexas.edu/grace/education>

The second of the Pathfinder missions, the Gravity Recovery and Climate Experiment (GRACE) employs a satellite-to-satellite microwave tracking system to measure the Earth's gravity field and its variability over time. Such measurements are directly coupled to long-wavelength ocean circulation processes and to the transport of ocean heat to the Earth's poles. **CONTACT: Email:** grace_edu@tsgc.utexas.edu. (Launched: 2002)

SeaWinds on ADEOS II

<http://winds.jpl.nasa.gov/education>

The Advanced Earth Observing Satellite (ADEOS) II is a joint mission with the National Space Development Agency of Japan (NASDA). The SeaWinds scatterometer is a specialized microwave radar that measures near-surface wind velocity (both speed and direction) over the Earth's oceans under all weather and cloud conditions. **CONTACT:** Peter Falcon, Scatterometer Projects Outreach Coordinator, Jet

Propulsion Laboratory, 4800 Oak Grove Dr., MS TR 1722-114, Pasadena, CA 91109-8099,
Phone: 818-393-0729, **Fax:** 818-354-8813,
Email: pcfaalcon@pop.jpl.nasa.gov. (Launched: 2002)

ICESat

<http://icesat.gsfc.nasa.gov/publicoutreach.html>

The Ice, Cloud and Land Elevation Satellite (ICESat) operates the Geoscience Laser Altimeter System (GLAS). GLAS is accurately measuring the elevation of the Earth's ice sheets, clouds and land. Data is available from the National Snow and Ice Data Center (<http://nsidc.org/daac/icesat>). **CONTACT:** **Email:** webmaster@icesat.gsfc.nasa.gov. (Launched: 2003)

SORCE

http://lasp.colorado.edu/sorce/edu_outreach.html

The Solar Radiation and Climate Experiment (SORCE) mission is providing state-of-the-art measurements of incoming x-ray, ultraviolet, visible, near-infrared and total solar radiation. The measurements provided by SORCE specifically address long-term climate change, natural variability and enhanced climate prediction, as well as atmospheric ozone and UV-B radiation. These measurements are critical to studies of the Sun and its effect on the Earth system.

CONTACT: Gary Rottman, Laboratory for Atmospheric and Space Physics, Campus Box 590, University of Colorado, Boulder, CO 80309-0590, **Phone:** 303-492-8324, **Email:** gary.rottman@lasp.colorado.edu. (Launched: 2003)

Aura

<http://aura.gsfc.nasa.gov/outreach>

Aura will study the Earth's ozone, air quality and climate. The mission is designed exclusively to conduct research on the composition, chemistry and dynamics of the Earth's upper and lower atmosphere.

CONTACT: Stephanie Stockman, Code 921, NASA Goddard Space Flight Center, **Email:** stockman@core2.gsfc.nasa.gov. (Scheduled launch: 2004)

GIFTS

<http://tellus.ssec.wisc.edu/outreach/gifts/gifts.htm>

The Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS) will make revolutionary advances in weather observations and potentially improve weather forecasts by making vertical and horizontal measurements of winds, water vapor and temperature in the Earth's atmosphere from a geosynchronous orbit. **CONTACT:** Arlene Levine, NASA Langley Research Center, Hampton, VA 23681-0001, **Phone:** 757-864-3318, **Email:** a.s.levine@larc.nasa.gov. (Scheduled launch: 2005)

CALIPSO

<http://www-calipso.larc.nasa.gov/outreach>

The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite will produce the first global three-dimensional view of aerosols and clouds. It will improve our understanding of the role aerosols and clouds play in the processes that govern climate responses and feedbacks, and improve the representation of aerosols and clouds in models, leading to more accurate predictions of climate change.

Accurate climate model predictions will provide international and national leaders with reliable information to make more informed policy decisions about global climate change. CALIPSO will fly in formation with Cloudsat (see next listing) and other satellites.

CONTACTS: Dianne Robinson, Outreach Director for CALIPSO, Interdisciplinary Science Center (ISC), Hampton University, **Email:** dianne.robinson@hamptonu.edu; Barbara Maggi, Assistant Outreach Director for CALIPSO, Center for Atmospheric Sciences (CAS), Hampton University, **Email:** barbara.maggi@hamptonu.edu. (Scheduled launch: 2005)

CloudSat

<http://cloudsat.atmos.colostate.edu/outreach>

CloudSat will provide vertical profiling from space of the full range of clouds, from thin cirrus to thick, precipitating convective clouds. It will also provide the first quantitative estimates of ice in clouds. The mission will fill a critical gap in the investigation of feedback mechanisms linking clouds to climate. CloudSat will orbit in formation as part of a constellation of satellites including Aqua, Aura and CALIPSO. One of the unique features that CloudSat brings to this constellation is the ability to fly a precise orbit, enabling the footprint of the CloudSat radar to be overlapped with that of the CALIPSO lidar, as well as with other instruments in the constellation. The precision of this overlap creates a unique multi-satellite observing system for studying atmospheric processes essential to the hydrological cycle. **CONTACT:** Debra Krumm, Outreach Coordinator, Department of Atmospheric Science, Colorado State University, Fort Collins, CO 80523-1371, **Phone:** 970-491-8790, **Email:** dkrumm@atmos.colostate.edu. (Scheduled launch: 2005.)

Informal Education

| | |
|---|----|
| Children | 29 |
| General Audiences (<i>K–12, Adult</i>) | 30 |
| Earth Science Data & Imagery | 31 |
| Background Resources for Informal Educators | |
| Brochures/Guides | 32 |
| Media/Writer's Guides | 33 |
| Web Sites | 33 |

Children

The Adventures of Amelia the Pigeon

<http://imagers.gsfc.nasa.gov/amelia>

This animated adventure engages children in a story-based scenario that emphasizes concepts of remote sensing and how NASA scientists use satellite imagery to better understand the Earth's environmental changes. The adventure introduces students to Earth science concepts, beginning with classifying objects in satellite images by shape, color and texture, building a foundation for interpretation and understanding of remote sensing. The story is set in New York City, chosen for its size, diversity and the visibility of prominent features in satellite imagery. **Recommended for: informal education, children ages 5–9.**

The Adventures of Echo the Bat

<http://imagers.gsfc.nasa.gov/k-4/index.html>

<http://catalog.core.nasa.gov/core.nsf/item/300.1-06P>

This picture book of Echo the Bat is accompanied by a set of activities that reinforce four basic themes or concepts fundamental to the interpretation of satellite imagery: perspective, shape and pattern, color and texture. Activities and activity sheets are also provided on a companion Web site: <http://imagers.gsfc.nasa.gov/k-4>. **Recommended for: children ages 5–10.**

The Air We Breathe

Available spring 2004 from NASA CORE:

<http://core.nasa.gov>

Children entering the classroom have different levels of experiences. The picture book *The Air We Breathe* is designed to provide a common level of knowledge about

Earth's atmosphere among students, and a foundation from which the teacher may launch a study of the atmosphere's composition and its importance to life.

Recommended for: K–4.

Alaska: A Bird's Eye View

<http://www.uaf.edu/asgp/k12>

In this Web-based, interactive story, Tutangiaq (Too-tang-geye-ack: nicknamed 2T), a Canada goose, flies across Alaska looking for his family. As he flies, he tells children about the fascinating 49th state. Children learn how Alaska was purchased from the Russians, and other facts about the state. They can also compare the size of Alaska to other states. 2T takes a flight across the volcanic chain in Alaska and helps students to interactively explore how scientists monitor volcanoes from satellite images in near-real time. At the coast, the bird also meets his walrus friend who shows him how the sea ice edge has receded and adversely affected marine life. Finally, 2T arrives in Fairbanks where children use satellite imagery to help 2T find and unite with his family. **Recommended for: grades 5–8.**

Our Dynamic Planet

<http://www.amnh.org/education/resources/rfl/web/earthmag>

The activities in *Our Dynamic Planet*, an online magazine for kids aged 7–11, encourage children to look more closely at geology in their local environments and support their exploration of a range of dynamic Earth processes, including the sequence of events during an explosive volcanic eruption, how life exists at deep-sea hydrothermal vents, the types of earthquakes associated with the three different types of plate boundaries and the climate impacts of El Niño. The magazine was developed by American Museum of Natural History. **Recommended for: children ages 7–11.**

Space Place

<http://spaceplace.jpl.nasa.gov>

Fun activities for children to do and make, while they learn about space and Earth science and the technology that enables science. The "Teachers Corner" on the Web site contains curriculum supplements originally published in the ITEAS' *Technology Teacher* magazine.

Recommended for: elementary–middle school.

General Audiences

Atlas of the Ocean: The Deep Frontier, 2001

<http://shop.nationalgeographic.com>

Featuring more than 150 photographs, maps and NASA satellite images, this atlas charts and celebrates every aspect of the ocean world, from tiny plankton to massive storm systems that rage across thousands of miles. Experts have contributed essays and sidebars on subjects as diverse as deep-sea archeology, plate tectonics, coral reefs, mapping techniques and El Niño. Readers also go behind the scenes to observe modern science at work, as researchers pursue promising leads in dozens of different but intertwined fields. Order online at the URL provided or from National Geographic Society, 1145 17th Street NW, Washington, DC 20036-4688. The *Atlas of the Ocean: The Deep Frontier Teacher's Guide* is a 30-page classroom activity guide that features content taken from the atlas. Subjects include undersea hot spots, underwater archaeology, bioluminescence, coral reefs, and polar sea exploration. Order the *Teachers' Guide* from NASA CORE (\$6, plus shipping). **The atlas is recommended for: formal and informal education audiences, grade 8–adult; the teachers' guide is recommended for middle–high school geography education.**

Destination Earth

<http://www.earth.nasa.gov>

Destination Earth is the official Web site for ESE. It includes current ESE news and events, sections on education for teachers and students, and information on current research opportunities. Many links to other information resources are also included.

Earth: Inside and Out

<http://www.thenewpress.com>

Earth: Inside and Out, edited by American Museum of Natural History (AMNH) Earth scientist Dr. Edmond A. Mathez, is a book of 19 essays written by leading Earth scientists that provides insight into the dynamic processes that shape the Earth. The essays are supported by case studies describing a range of current research projects (including Looking for Life in Antarctica and Mars, Mapping Mt. Rainer, and Mapping Hot Springs on the Deep Ocean Floor) and profiles of historically significant Earth scientists (Including Inge Lehmann, Milutin Milankovitch and Harold C. Urey). The essays, case studies, and profiles are organized along the same themes explored in the AMNH Gottesman Hall of

Planet Earth, (How do we read the rocks?; How has the Earth evolved?; Why are there ocean basins, mountains and continents?; What causes climate and climate change?; Why is the Earth habitable?)—a large, permanent exhibition that opened at the Museum in 1999.

Recommended for: high school+.

Earth Observatory

<http://earthobservatory.nasa.gov>

NASA's *Earth Observatory* is an interactive Web-based magazine where the science-attentive public can obtain new satellite imagery and scientific information about our home planet. Visit the *Earth Observatory* to read feature articles on wide-ranging Earth system science topics, download datasets and images for analysis, read breaking news, learn about current and planned Earth missions, search an online library for reference materials, track natural hazards around the world in near-real time, and access interactive experiments and classroom activities. **Recommended for: general public, media, informal educators, and middle school–post secondary instruction.**

Earth Science Picture of the Day (EPOD)

<http://epod.usra.edu>

The EPOD Web site is a collaboration between NASA's Goddard Space Flight Center and the Universities Space Research Association. A new photograph or image highlighting an interesting or unusual aspect of the Earth's system appears every day. Each picture is accompanied by a detailed description and related links. Search the archive by keyword or browse by field or topic. **Recommended for: middle school+, informal education.**

Earth Update

<http://earth.rice.edu/connected/earthupdate.html>
<http://core.nasa.gov>

Rice Space Institute developed this CD-ROM, which contains Earth science information, movies and classroom activities. The CD is suitable as a stand-alone museum kiosk or for use in a school classroom or library. If the user's computer is connected to the Internet, today's data can be downloaded with a single click. Each "sphere" (atmosphere, biosphere, cryosphere, geosphere and hydrosphere) can be run separately or as the linked Earth Update. Each sphere includes sections What (What is the atmosphere), Who (Who studies the biosphere), Why (Why do we study the cryosphere?), and How (How do we study the geosphere?). Classroom activities aligned with national science, math and geography standards are included on the CD. Also available from NASA CORE.

Recommended for: K–12 and informal education.

Where on Earth...?" MISR Mystery Image Quizzes

<http://www-misr.jpl.nasa.gov/education/whereonearth.html>

Embark on a geographical adventure with NASA's Multi-angle Imaging SpectroRadiometer (MISR) Mystery Image Quizzes. These puzzles are designed to inspire understanding of the physical, biological and human processes that influence our home planet and cover topics from Archaeology to Zoology. Several resources for discovering and revealing the meaning of image features may help new geographical detectives to solve the challenging quiz questions. A new "Where on Earth...?" mystery quiz appears as the MISR "latest featured image" approximately once every two months.

Answers are published on the MISR web site (<http://www-misr.jpl.nasa.gov>). The names and home towns of respondents who answer all questions correctly by the deadline will also be published in the order responses were received. The first three people on this list who are not affiliated with NASA, JPL or MISR and who have not previously won a prize will be sent a print of the image.

Recommended for: informal education.

Windows to the Universe

<http://www.windows.ucar.edu>

Windows to the Universe brings together scientific content on Earth and space sciences with interdisciplinary content on the arts and humanities. Three levels of content are provided: students (K–12 through undergraduate), teachers, and browsing adults. The site includes a rich array of documents, images, movies, animations, sounds, games and data that brings science to life for students, teachers, and the interested user.

Recommended for: K–12, informal education.

Earth Science Data & Imagery

See also the section on Web sites (p. 33) for a list of individual Earth science missions.

Earth Observatory

<http://earthobservatory.nasa.gov>

NASA's *Earth Observatory* is an interactive Web-based magazine where the science-attentive public can obtain new satellite imagery and scientific information about our home planet. Visit the *Earth Observatory* to read feature articles on wide-ranging Earth system science topics, download datasets and images for analysis, read breaking news, learn about current and planned Earth missions, search an online

library for reference materials, track natural hazards around the world in near-real time, and access interactive experiments and classroom activities. **Recommended for: general public, media, informal educators, and middle school–post secondary instruction.**

Earth Science Picture of the Day (EPOD)

<http://epod.usra.edu>

The EPOD Web site is a collaboration between NASA's Goddard Space Flight Center and the Universities Space Research Association. A new photograph or image highlighting an interesting or unusual aspect of the Earth's system appears every day. Each picture is accompanied by a detailed description and related links. Search the archive by keyword or browse by field or topic. **Recommended for: middle school+, informal education.**

Gateway to Astronaut Photography of Earth

<http://eol.jsc.nasa.gov>

This Web site hosts the best and most complete online collection of astronaut photographs of the Earth, including over 480,000 photos from Space Shuttle and the International Space Station. Users can search the database of photos by geographic coordinates or region, mission, features, cloud cover and many other options. The site also features an image of the week, as well as special collections of images, including: Cities, Earth Landscape, Earth-Human Interaction, Distinctive Features, Hurricanes and Weather, Earth's Water Habitat, and Geographical Regions.

United States of America Digital Landsat Mosaics: a 4-CD set of Landsat satellite imagery of the fifty states

<http://catalog.core.nasa.gov/core.nsf/item/400.1-52>

Using the US Digital Landsat Mosaics we can increase our understanding of Earth system science and the effects humans have on the global environment. The mosaics were developed primarily from data collected by the Landsat 4 and Landsat 5 satellites as they orbited the Earth ten or more years ago. This historical imagery is a valuable record of the conditions on Earth around the year 1990. The CD was developed by NASA Stennis Space Center and the US Geological Survey. It also includes a basic Landsat tutorial. **Recommended for: high school–adult.**

Visible Earth

<http://visibleearth.nasa.gov>

This companion site to the NASA *Earth Observatory* (<http://earthobservatory.nasa.gov>) is a comprehensive image gallery for access to NASA Earth science images, animations, and data visualizations. Most resources are available digitally at multiple resolutions, with captions and metadata. **Recommended for: media and general public.**

Where on Earth...?" MISR Mystery Image Quizzes

<http://www-misr.jpl.nasa.gov/education/whereonearth.html>

Embark on a geographical adventure with NASA's Multi-angle Imaging SpectroRadiometer (MISR) Mystery Image Quizzes. These puzzles are designed to inspire understanding of the physical, biological and human processes that influence our home planet and cover topics from Archaeology to Zoology. Several resources for discovering and revealing the meaning of image features may help new geographical detectives to solve the challenging quiz questions. A new "Where on Earth...?" mystery quiz appears as the MISR "latest featured image" approximately once every two months.

Answers are published on the MISR web site (<http://www-misr.jpl.nasa.gov>). The names and home towns of respondents who answer all questions correctly by the deadline will also be published in the order responses were received. The first three people on this list who are not affiliated with NASA, JPL or MISR and who have not previously won a prize will be sent a print of the image.

Recommended for: informal education.

Background Resources for Informal Educators

■ BROCHURES/GUIDES

Aqua Brochure

http://eosps0.gsfc.nasa.gov/ftp_docs/Aqua_brochure.pdf

"Aqua," Latin for "water," is a NASA Earth Science satellite mission named for the large amount of information that the mission will be collecting about the Earth's water cycle, including evaporation from the oceans, water vapor in the atmosphere, clouds, precipitation, soil moisture, sea ice, land ice and snow cover on the land and ice. Additional variables also being measured by Aqua include radiative energy fluxes, aerosols, vegetation cover on the land, phytoplankton and dissolved organic matter in the oceans and air, land and water temperatures. This brochure provides a comprehensive overview of the Aqua spacecraft, instruments, science and data products.

Recommended for: post secondary and resource for informal educators.

Climate Change Presentation Kit, 1999

<http://www.epa.gov/enviroed/globalclimate.html>

The Climate Change Presentation Kit is offered as a resource to help prepare talks for students or the general public. The toolkit allows teachers the option of picking and choosing the components that they would need to communicate climate change issues to audiences. It contains fact sheets, a PowerPoint slide presentation and interactive activities that are designed to interest audiences of all levels. Order this free CD-ROM at the Web site provided. **Recommended for: elementary–college educators, informal educators.**

GRACE Brochure

http://eosps0.gsfc.nasa.gov/ftp_docs/GRACE.pdf

Gravity controls everything from the motion of the ocean tides to the expansion of the entire Universe. To learn more about the mysteries of gravity, twin NASA satellites named GRACE, short for the Gravity Recovery and Climate Experiment, are being launched to make detailed measurements of Earth's gravity field. This experiment could lead to discoveries about gravity and Earth's natural systems, which could have substantial benefits for society and the world's population.

Recommended for: post secondary and resource for informal educators.

ICESat: Ice, Cloud, and land Elevation Satellite

http://icesat.gsfc.nasa.gov/ICESat_Brochure.pdf

The mission brochure for NASA's ICESat, which was launched January 12, 2003. ICESat is the benchmark Earth Observing System mission for measuring ice sheet mass balance, cloud and aerosol heights, as well as land topography and vegetation characteristics.

Recommended for: college/university instructors and students; informal educators.

MODIS Brochure

http://eosps0.gsfc.nasa.gov/ftp_docs/MODIS.pdf

The first NASA Earth Observing System (EOS) satellite, called Terra, was launched on December 18, 1999, carrying five remote sensors. The most comprehensive EOS sensor is MODIS, the Moderate Resolution Imaging Spectroradiometer. MODIS offers a unique combination of features: it detects a wide spectral range of electromagnetic energy; it takes measurements at three spatial resolutions (levels of detail); it takes measurements all day, every day; and it has a wide field of view. This continual, comprehensive coverage allows MODIS to complete an electromagnetic picture of the globe every two days.

Recommended for: post secondary and background resource for informal educators.

■ MEDIA/WRITER'S GUIDES

NASA's Earth Observing System—Global Change Media Directory 2001

http://eospsso.gsfc.nasa.gov/ftp_docs/2001_media_directory.pdf

This publication contains an alphabetical list of NASA Earth Observing System researchers, with contact information and their areas of expertise. It also contains indices for areas of expertise and location, as well as media resources and public affairs contacts. An online version of the directory is titled *Global Change Experts Directory* and is available at: <http://dough.gsfc.nasa.gov:591/eobsearch.html>.

Recommended for: broadcast and print media.

Science Writers' Guide to Aqua

http://eospsso.gsfc.nasa.gov/ftp_docs/Aqua_Sci_Writer's_Guide.pdf

The *Science Writers Guide to Aqua* provides a comprehensive overview of the Aqua mission, instruments, research, science teams and public affairs contacts. All information is provided to aid the professional science writer in writing stories and articles related to the Aqua mission. **Recommended for:** science writers/media.

Science Writers Guide to Landsat-7

http://eospsso.gsfc.nasa.gov/ftp_docs/Landsat7_writer_guide.pdf

Landsat 7 is advancing several areas of Earth science, including monitoring croplands and mapping Antarctic ice streams. This guide profiles several Landsat 7 research projects, and provides background and contact information. **Recommended for:** science writers/media.

Science Writers Guide to Terra

http://eospsso.gsfc.nasa.gov/ftp_docs/Terra_Writers_Guide.pdf

The launch of NASA's Terra spacecraft marked a new era of comprehensive monitoring of the Earth's atmosphere, oceans and continents from a single space-based platform. Data from the 5 Terra instruments are creating continuous, long-term records of the state of the land, oceans and atmosphere. Together with data from other satellite systems launched by NASA and other countries, Terra will inaugurate a new self-consistent data record that will be gathered over the next 15 years. This guide provides research profiles, as well as extensive background and contact information for Terra.

Recommended for: science writers/media.

■ WEB SITES

EOS Project Science Office

<http://eospsso.gsfc.nasa.gov/>

The Earth Observing System (EOS) is the centerpiece of NASA's ESE. It is composed of a series of satellites, a science component and a data system supporting a coordinated series of satellites—for long-term global observations of the land surface, biosphere, solid Earth, atmosphere and oceans. The EOS Project Science Office is committed to bringing program information and resources to program scientists and the general public alike. Visit the project's Web site to find resources for educators, including educational links and publications from the EOS program. **Recommended for:** elementary—secondary educators, undergraduate—graduate.

NASA Earth Science Missions—Education Programs and Resources

Many of NASA's Earth science missions have an education and/or public outreach component. These efforts include a wide variety of activities and resources for educators, students and the public, including teacher workshops, public programs and events, and curriculum and classroom materials. Visit the Web sites listed with each mission for specific information on a mission's programs and resources, including access to satellite imagery and other data. Missions are listed by year of launch or scheduled launch.

TOPEX/Poseidon

<http://sealevel.jpl.nasa.gov/education/education.html>

Jointly sponsored by NASA and CNES, the French space agency, the TOPEX/Poseidon satellite uses radar altimeters to continuously survey ocean surface height. The Jason-1 satellite joined TOPEX/Poseidon in orbit in 2001 to collect similar data.

Scientists are using TOPEX/Poseidon and Jason-1 data to learn more about global ocean circulation patterns, including phenomena such as El Niño/La Niña. Oceans are a key mechanism in transporting heat from the Sun around the globe. Researchers are working to improve understanding of the role oceans play in controlling seasonal variations and longer-term climate changes. Ocean altimetry data are also used for operational purposes, including ship routing, fisheries management, hurricane forecasting and support of underwater activities like cable laying. **CONTACT:** Annie Richardson or Mona Jasnow, Jet Propulsion Laboratory, **Email:** topex@jpl.nasa.gov. (Launched: 1992)

SeaWiFS

<http://seawifs.gsfc.nasa.gov/SEAWIFS/TEACHERS>

The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) is providing quantitative data on global ocean bio-optical properties. Subtle changes in ocean color signify various types and quantities of marine phytoplankton (microscopic marine plants), the knowledge of which has both scientific and practical applications. SeaWiFS has helped us to not only monitor the short-term spatial and temporal variability in the ocean's biology, but also to have the first well-calibrated, long-term data set that allows us to quantify the ocean's biological response to global change. (Launched: 1997)

Tropical Rainfall Measuring Mission (TRMM)

<http://trmm.gsfc.nasa.gov>

<http://strategies.org/TRMM.html>

TRMM is a joint mission between NASA and the National Space Development Agency of Japan (NASDA). It is designed to monitor and study tropical rainfall and the associated release of energy that helps to power the global atmospheric circulations shaping both weather and climate around the world.

CONTACT: Jeffrey Halverson, TRMM Education and Outreach Scientist, Code 912, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6333, **Email:** halverson@agnes.gsfc.nasa.gov. (1997 launch)

ACRIMSAT

<http://acrim.jpl.nasa.gov/education/eduindex.html>

Using the Active Cavity Radiometer Irradiance Monitor (ACRIM) III instrument, the ACRIMSAT spacecraft provides long-term, precise measurements of the total amount of the Sun's energy that falls on our planet's surface, oceans and atmosphere. ACRIM I was the first instrument to clearly show that the energy from the Sun is not a constant value but instead varies over time. These energy changes are small but significant, and they cycle approximately every 11 years. ACRIMSAT data is vital to helping scientists build more accurate climate models. (Launched: 1999)

Landsat 7

<http://landsat.gsfc.nasa.gov/main/education.html>

The Landsat 7 satellite is acquiring remotely-sensed images of land surface and coastal regions for global change research, regional environmental change studies, national security uses and other civil and commercial purposes. The Landsat 7 data set will provide the first high-resolution view of both seasonal and interannual changes in the terrestrial environment.

CONTACT: Stephanie Stockman, Code 921, NASA Goddard Space Flight Center, **Phone:** 301-614-6457, **Email:** stockman@core2.gsfc.nasa.gov. (Launched: 1999)

SeaWinds on QuikSCAT

<http://winds.jpl.nasa.gov/education>

The SeaWinds instrument on the QuikSCAT satellite is a "quick recovery" effort to fill the gap created by the loss of data from the NASA Scatterometer (NSCAT) when the satellite lost power in June of 1997.

SeaWinds is a specialized microwave radar that measures near-surface wind speed and direction over the Earth's oceans under all weather and cloud conditions.

CONTACT: Peter Falcon, Scatterometer Projects Outreach Coordinator, Jet Propulsion Laboratory, 4800 Oak Grove Dr., MS TR 1722-114, Pasadena, CA 91109-8099, **Phone:** 818-393-0729, **Fax:** 818-354-8813, **Email:** pcfalcon@pop.jpl.nasa.gov. (Launched: 1999)

Terra

<http://terra.nasa.gov>

Terra, the flagship satellite of NASA's Earth Observing System, is collecting what will ultimately become a new, 15-year global data set on the state of the land, oceans and atmosphere. Data from this mission are used in many research and commercial applications. **CONTACT:** David Herring, Code 913, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-6219, **Email:** dherring@climate.gsfc.nasa.gov. (Launched: 1999)

EO-1

<http://eo1.gsfc.nasa.gov/Education/eo1Education.html>

Earth Observing-1 (EO-1) is the first flight of NASA's New Millennium Program (NMP). Its mission is to validate technologies that will reduce the cost and increase capabilities of upcoming land-imaging missions. As a result of EO-1, future spacecraft will be an order of magnitude smaller and lighter than current versions. **CONTACT:** Joseph Young, EO-1 Mission Technology Transfer Manager, NASA Goddard Space Flight Center, **Phone:** 301-286-8146, **Email:** joseph.p.young.1@gsfc.nasa.gov. (Launched: 2000)

Jason-1

<http://sealevel.jpl.nasa.gov/education/education.html>

Jointly sponsored by NASA and CNES, the French space agency, Jason-1 is a follow-on mission to TOPEX/Poseidon. See TOPEX/Poseidon (1992 launch) listing on p. 33 for additional details. (Launched: 2001)

SAGE III/METEOR-3M

<http://www-sage3.larc.nasa.gov>

The Stratospheric Aerosol and Gas Experiment (SAGE) III mission on the Russian Meteor-3M spacecraft seeks to enhance our understanding of natural and human-derived atmospheric processes by providing high-latitude, long-term measurements of the vertical structure of aerosols, ozone, water vapor and other important trace gases in the upper troposphere and stratosphere. **CONTACT:** David Woods, NASA Langley Research Center, Hampton, VA 23681, **Email:** d.c.woods@larc.nasa.gov. (Launched: 2001)

Aqua

<http://aqua.nasa.gov>

Latin for "water," Aqua is named for the large amount of information the mission is collecting about the Earth's water cycle, including evaporation from the oceans, water vapor in the atmosphere, clouds, precipitation, soil moisture, sea ice, land ice and snow cover on land and ice. Additional variables also being measured by Aqua include radiative energy fluxes, aerosols, vegetation cover on land, phytoplankton and dissolved organic matter in the oceans and air, land and water temperatures. **CONTACTS:** Claire Parkinson, Code 971, NASA Goddard Space Flight Center, Greenbelt, MD 20771, **Phone:** 301-614-5715, **Email:** claire.l.parkinson@nasa.gov; Steve Graham, Code 900, NASA Goddard Space Flight Center, **Phone:** 301-614-5561, **Email:** steven.m.graham.2@gsfc.nasa.gov. (Launched: 2002)

GRACE

<http://www.csr.utexas.edu/grace/education>

The second of the Pathfinder missions, the Gravity Recovery and Climate Experiment (GRACE) employs a satellite-to-satellite microwave tracking system to measure the Earth's gravity field and its variability over time. Such measurements are directly coupled to long-wavelength ocean circulation processes and to the transport of ocean heat to the Earth's poles. **CONTACT:** **Email:** grace_edu@tsgc.utexas.edu. (Launched: 2002)

SeaWinds on ADEOS II

<http://winds.jpl.nasa.gov/education>

The Advanced Earth Observing Satellite (ADEOS) II is a joint mission with the National Space Development Agency of Japan (NASDA). The SeaWinds scatterometer is a specialized microwave radar that measures near-surface wind velocity (both speed and direction) over the Earth's oceans under all weather and cloud conditions. **CONTACT:** Peter Falcon, Scatterometer Projects Outreach Coordinator, Jet

Propulsion Laboratory, 4800 Oak Grove Dr., MS TR 1722-114, Pasadena, CA 91109-8099, **Phone:** 818-393-0729, **Fax:** 818-354-8813, **Email:** pcfalcon@pop.jpl.nasa.gov. (Launched: 2002)

ICESat

<http://icesat.gsfc.nasa.gov/publicoutreach.html>

The Ice, Cloud and Land Elevation Satellite (ICESat) operates the Geoscience Laser Altimeter System (GLAS). GLAS is accurately measuring the elevation of the Earth's ice sheets, clouds and land. Data is available from the National Snow and Ice Data Center (<http://nsidc.org/daac/icesat>). **CONTACT:** **Email:** webmaster@icesat0.gsfc.nasa.gov. (Launched: 2003)

SORCE

http://lasp.colorado.edu/sorce/edu_outreach.html

The Solar Radiation and Climate Experiment (SORCE) mission is providing state-of-the-art measurements of incoming x-ray, ultraviolet, visible, near-infrared and total solar radiation. The measurements provided by SORCE specifically address long-term climate change, natural variability and enhanced climate prediction, as well as atmospheric ozone and UV-B radiation. These measurements are critical to studies of the Sun and its effect on the Earth system. **CONTACT:** Gary Rottman, Laboratory for Atmospheric and Space Physics, Campus Box 590, University of Colorado, Boulder, CO 80309-0590, **Phone:** 303-492-8324, **Email:** gary.rottman@lasp.colorado.edu. (Launched: 2003)

Aura

<http://aura.gsfc.nasa.gov/outreach>

Aura will study the Earth's ozone, air quality and climate. The mission is designed exclusively to conduct research on the composition, chemistry and dynamics of the Earth's upper and lower atmosphere. **CONTACT:** Stephanie Stockman, Code 921, NASA Goddard Space Flight Center, **Email:** stockman@core2.gsfc.nasa.gov. (Scheduled launch: 2004)

GIFTS

<http://tellus.ssec.wisc.edu/outreach/gifts/gifts.htm>

The Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS) will make revolutionary advances in weather observations and potentially improve weather forecasts by making vertical and horizontal measurements of winds, water vapor and temperature in the Earth's atmosphere from a geosynchronous orbit. **CONTACT:** Arlene Levine, NASA Langley Research Center, Hampton, VA 23681-0001, **Phone:** 757-864-3318, **Email:** a.s.levine@larc.nasa.gov. (Scheduled launch: 2005)

CALIPSO

<http://www-calipso.larc.nasa.gov/outreach>

The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite will produce the first global three-dimensional view of aerosols and clouds. It will improve our understanding of the role aerosols and clouds play in the processes that govern climate responses and feedbacks, and improve the representation of aerosols and clouds in models, leading to more accurate predictions of climate change.

Accurate climate model predictions will provide international and national leaders with reliable information to make more informed policy decisions about global climate change. CALIPSO will fly in formation with Cloudsat (see next listing) and other satellites.

CONTACTS: Dianne Robinson, Outreach Director for CALIPSO, Interdisciplinary Science Center (ISC), Hampton University, **Email:** dianne.robinson@hamptonu.edu; Barbara Maggi, Assistant Outreach Director for CALIPSO, Center for Atmospheric Sciences (CAS), Hampton University, **Email:** barbara.maggi@hamptonu.edu. (Scheduled launch: 2005)

CloudSat

<http://cloudsat.atmos.colostate.edu/outreach>

CloudSat will provide vertical profiling from space of the full range of clouds, from thin cirrus to thick, precipitating convective clouds. It will also provide the first quantitative estimates of ice in clouds. The mission will fill a critical gap in the investigation of feedback mechanisms linking clouds to climate. CloudSat will orbit in formation as part of a constellation of satellites including Aqua, Aura and CALIPSO. One of the unique features that CloudSat brings to this constellation is the ability to fly a precise orbit, enabling the footprint of the CloudSat radar to be overlapped with that of the CALIPSO lidar, as well as with other instruments in the constellation. The precision of this overlap creates a unique multi-satellite observing system for studying atmospheric processes essential to the hydrological cycle. **CONTACT:** Debra Krumm, Outreach Coordinator, Department of Atmospheric Science, Colorado State University, Fort Collins, CO 80523-1371, **Phone:** 970-491-8790, **Email:** dkrumm@atmos.colostate.edu. (Scheduled launch: 2005.)



NASA Resources for Educators

Central Operation of Resources for Educators (CORE)

<http://core.nasa.gov>

NASA CORE was established for the national and international distribution of NASA-produced educational materials in multimedia format, including videotapes, activity kits, CD-ROMs, DVDs, slide programs and printed material. NASA's educational materials provide a springboard for classroom discussion of Earth science, mathematics, technology, careers and other topics. Catalog and order form are available at the Web site, or by contacting: NASA CORE, Lorain County Joint Vocational School, 15181 Route 58 South, Oberlin, OH 44074, *Phone:* 1-866-776-CORE, *Fax:* 1-866-775-1460, *Email:* nasaco@leeca.org.

Educator Resource Center Network (ERCN)

<http://education.nasa.gov/ercn>

The ERCN provides educators with in-service and pre-service training, demonstrations and access to science, mathematics and technology instructional products based on NASA's unique missions and results. NASA Educator Resource Centers (ERCs) are located on or near NASA field centers, museums, colleges or other nonprofit organizations. Educators may preview, copy or receive NASA materials at these sites. The ERCN Web site provides a complete listing of all ERCs. The following list includes those located on or near NASA field centers and the regions they serve:

AK, Northern CA, HI, ID, MT, NV, OR, UT, WA, WY

Educator Resource Center

NASA Ames Research Center

Mail Stop 253-2

Moffett Field, CA 94035-1000

Phone: 650-604-3574

Email: erc@mail.arc.nasa.gov

Web site: <http://amesnews.arc.nasa.gov/erc>

AZ and Southern CA

Educator Resource Center

NASA Dryden Flight Research Center

MS 4839

PO Box 273

Edwards, CA 93523-0273

Phone: 661-276-2445

Email: michelle.davis@dfrc.nasa.gov

Web site: <http://www.dfrc.nasa.gov/Education/ERC>

IL, IN, MI, MN, OH, WI

Educator Resource Center

NASA Glenn Research Center

Mail Stop 8-1

21000 Brookpark Rd.

Cleveland, OH 44135

Phone: 216-433-2017

Email: erc@grc.nasa.gov

Web site: <http://www.grc.nasa.gov/WWW/OEP/ERCN.htm>

CT, DC, DE, MD, ME, MA, NH, NJ, NY, PA, RI, VT

Educator Resource Center

NASA Goddard Space Flight Center

Code 130.3

Greenbelt, MD 20771

Phone: 301-286-8570

Web site: <http://pao.gsfc.nasa.gov/gsfcd/educ/trl/welcome.html>

VA and MD's Eastern Shores

Educator Resource Center

NASA GSFC/Wallops Flight Facility

Visitor Center, Bldg. J-17

Wallops Island, VA 23337

Phone: 757-824-2214

Email: dshreves@pop100.gsfc.nasa.gov

Web site: <http://www.wff.nasa.gov/vc/ERC.htm>

CA

Educator Resource Center

NASA Jet Propulsion Laboratory

Village at Indian Hill

1460 E. Holt Ave., Suite 20

Pomona, CA 91767

Phone: 909-397-4420

Web site: <http://education.jpl.nasa.gov/resources>

CO, KS, ND, NE, NM, OK, SD, TX

Educator Resource Center

NASA Johnson Space Center

Space Center Houston

1601 NASA Road One

Houston, TX 77058

Phone: 281-244-2129

Email: erc@spacecenter.org

Web site: http://www.spacecenter.org/educator_resource.html

FL, GA, Puerto Rico, Virgin Islands

Educator Resource Center

NASA Kennedy Space Center

Mail Code ERC

KSC, FL 32899

Phone: 321-867-4090

Email: birdette.brown-1@ksc.nasa.gov

Web site: <http://education.ksc.nasa.gov/erc.htm>

KY, NC, SC, VA, WV

Educator Resource Center

NASA Langley Research Center

600 Settlers Landing Rd.

Hampton, VA 23669-4033

Phone: 757-727-0900 Ext. 757

Email: nkoltun@vasc.org

Web site: <http://www.vasc.org/erc>

AL, AR, IA, LA, MO, TN

Educator Resource Center

NASA Marshall Space Flight Center

U.S. Space and Rocket Center

One Tranquility Base

Huntsville, AL 35807

Phone: 256-544-5812

Web site: <http://erc.msfc.nasa.gov>

MS

Educator Resource Center

NASA Stennis Space Center

Mail Stop 1200

Stennis Space Center, MS 39529-6000

Phone: 228-688-3506

Web site: <http://education.ssc.nasa.gov/erc>

Education Home Page

<http://education.nasa.gov>

The NASA Education Home Page serves as the portal for information regarding educational programs and services offered by NASA. Specific details and contact information are provided for all of NASA's educational efforts, including links to NASA field center education offices and contacts within each state and the territories of Guam, Puerto Rico and the Virgin Islands.

NASA Portal

<http://www.nasa.gov>

To inform, involve and inspire... With these goals in mind, the NASA Portal serves as the gateway for information regarding content, programs and services offered by NASA for the general public and, specifically, for the educational community. The collection of educational information is organized by key user communities—kids, students and educators (formal and informal)—and by grade level—K–4, 5–8, 9–12 and post secondary. Visit the NASA Portal and begin a journey of personal discovery.

NASA Television

<http://www.nasa.gov/ntv>

NASA Television provides real-time coverage of NASA activities and missions, as well as educational programming for students, teachers and the general public. Programming includes Space Station and Shuttle mission coverage, live special events, interactive educational shows, electronic field trips, aviation and space news, and historical NASA footage. See Web site for program listings. Regularly scheduled shows may be preempted by breaking news or live events.

Spacelink

<http://spacelink.nasa.gov>

NASA Spacelink is an electronic resource developed specifically for the educational community. The heart of Spacelink is a digital library of NASA's educational and scientific resources, with hundreds of subject areas organized especially for educators and students. Spacelink is also the official home to electronic versions of NASA's educational products. A complete listing of products can be found at <http://spacelink.nasa.gov/products>.

Acknowledgements/Photo Credits

Acknowledgements

Responsible NASA Officials:

Dr. Ming-Ying Wei, NASA Headquarters
Dr. Diane Schweizer, NASA Headquarters
Dr. Paula Coble, NASA Headquarters

Editor: Theresa Schwerin, Institute for Global Environmental Strategies

Graphic Design: Susie Duckworth, Duckworth Illustration and Graphic Design Studio

Editorial Support: Claudia Dauksys and Dan Stillman, Institute for Global Environmental Strategies

Photo Credits

■ Cover Image Description

This image is from the ASTER sensor onboard NASA's Terra Satellite. The image shows a great sea of linear dunes in part of the Rub' al Khali, or the Empty Quarter. The dunes are yellow due to the presence of iron oxide minerals. The inter-dune area is made up of clays and silt and appears blue due to its high reflectance. The Rub' al Khali is the world's largest continuous sand desert. It covers about 650,000 sq. kilometers (250,966 square miles) and lies mainly in southern Saudi Arabia, though it does extend into the United Arab Emirates, Oman, and Yemen. One of the world's driest areas, it is uninhabited except for the Bedouin nomads who cross it. This image is available on the Visible Earth Web site at: <http://visibleearth.nasa.gov/cgi-bin/viewrecord?5372>.

CREDIT: NASA GSFC, MITI, ERSDAC, JAROS, and U.S./Japan ASTER Science Team.

■ Cover Photos

(Top to bottom)

Participants in the Elizabeth City State University (ECSU) Earth System Science Academy 2003.

CREDIT: Photo provided by Dr. Linda Hayden.

Tom Nolan, NASA Jet Propulsion Laboratory (middle), onboard the 2003 NOAA Teacher at Sea Program.

CREDIT: Photo provided by Tom Nolan.

Participants in the Elizabeth City State University (ECSU) Earth System Science Academy 2003.

CREDIT: Photo provided by Dr. Linda Hayden.

Participants in the 2003 NASA Earth and Space Science Education Products Workshop. NASA LaRC.

CREDIT: Photo provided by Stacey Rudolph, Institute for Global Environmental Strategies.

■ Table of Contents

(P. 1, left to right)

GLOBE Program students take aerosol measurements using a hand-held sun photometer.

CREDIT: Photo provided by Charles Kellett.

Tom Nolan, NASA Jet Propulsion Laboratory (middle), onboard the 2003 NOAA Teacher at Sea Program.

CREDIT: Photo provided by Tom Nolan.

■ Introduction

(P. 1, left to right)

Participants in the Elizabeth City State University (ECSU) Earth System Science Academy 2003.

CREDIT: Photo provided by Dr. Linda Hayden.

Participants in the 2003 NASA Earth and Space Science Education Products Workshop. NASA LaRC.

CREDIT: Photo provided by Stacey Rudolph, Institute for Global Environmental Strategies.

■ Elementary & Secondary

(P. 1, left to right)

Participants in the Elizabeth City State University (ECSU) Earth System Science Academy 2003.

CREDIT: Photo provided by Dr. Linda Hayden.

Third-grade students learn about NASA Earth science with Mission Geography lessons.

CREDIT: Photo provided by Keith Bellinger, Longstreth Elementary.

■ Higher Education

(P. 1)

Participants in the 2003 NASA Earth and Space Science Education Products Workshop. NASA LaRC.

CREDIT: Photo provided by Stacey Rudolph, Institute for Global Environmental Strategies.

■ Informal Education

(P. 1, left to right)

Participants in the Elizabeth City State University (ECSU) Earth System Science Academy 2003.

CREDIT: Photo provided by Dr. Linda Hayden.

Participants in the Elizabeth City State University (ECSU) 2003 K-12 Earth Science Summer Program.

CREDIT: Photo provided by Dr. Linda Hayden.

■ Products & Resources

(P. 1, left to right)

NASA Earth Crew broadcast, December 1, 2003.

CREDIT: Photo provided by NASA HQ.

Participants in the 2003 NASA Earth and Space Science Education Products Workshop. NASA LaRC.

CREDIT: Photo provided by Stacey Rudolph, Institute for Global Environmental Strategies.

■ NASA Resources for Educators

(P. 1, left to right)

Participants in the 2003 NASA Earth and Space Science Education Products Workshop. NASA LaRC.

CREDIT: Photo provided by Stacey Rudolph, Institute for Global Environmental Strategies.

NASA Earth Crew broadcast, December 1, 2003.

CREDIT: Photo provided by NASA HQ.